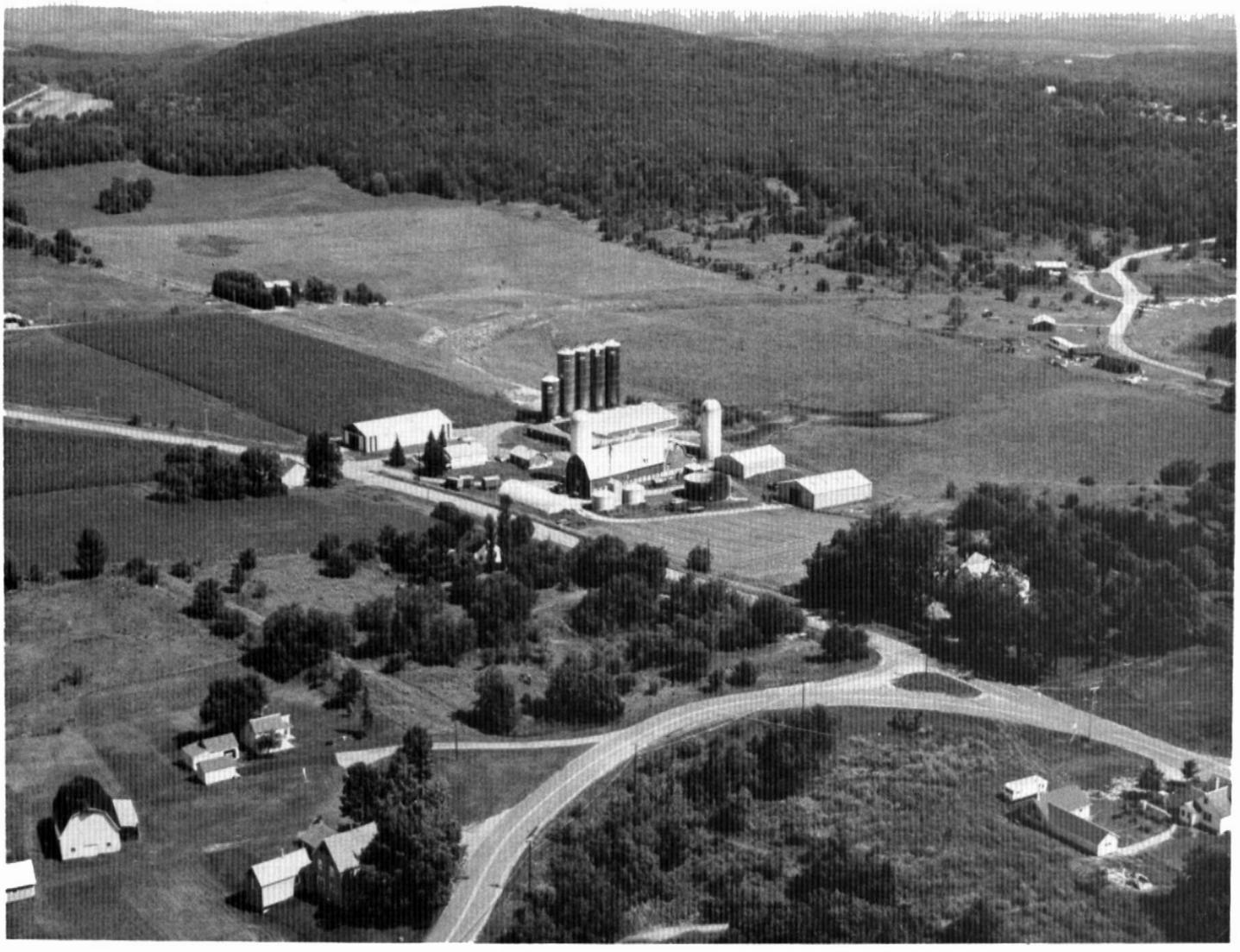
United States Department of Agriculture

Soil Conservation Service

In cooperation with Michigan Department of Agriculture, Michigan Agricultural Experiment Station, and Michigan Technological University

Soil Survey of Dickinson County, Michigan



How To Use This Soil Survey

General Soil Map

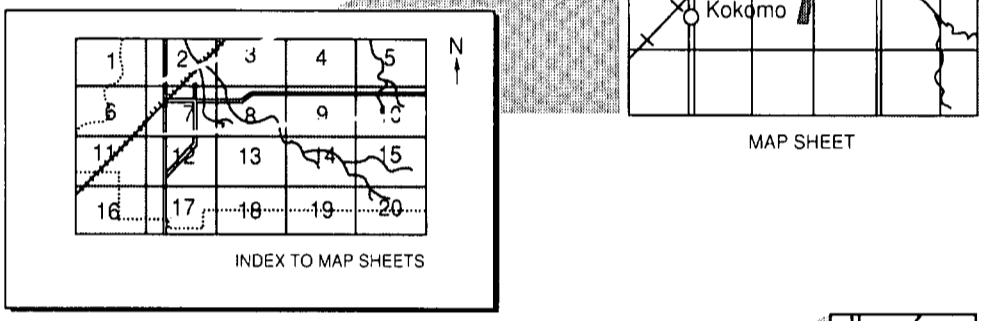
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

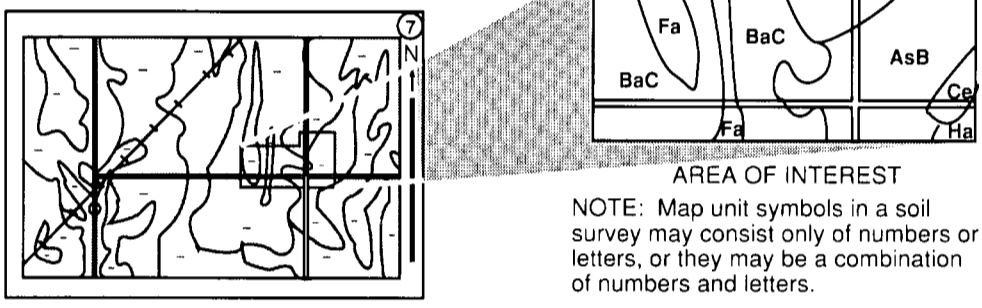
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, handicap, or age.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1985. This survey was made cooperatively by the Soil Conservation Service, Michigan Department of Agriculture, Michigan Agricultural Experiment Station, and Michigan Technological University. It is part of the technical assistance furnished to the Dickinson County Soil and Water Conservation District. Financial assistance was provided by the Dickinson County Board of Commissioners.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: An area of the Pemene-Emmet-Cathro association. Dairying and other types of agriculture are important parts of the economy in Dickinson County.

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Soil Series

Issued August 1989

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Dickinson County, Michigan. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Homer R. Hilner
State Conservationist
Soil Conservation Service

Location of Dickinson County in Michigan.

Soil Survey of Dickinson County, Michigan

By Lyle H. Linsemier, Soil Conservation Service

Fieldwork by Joseph Calus, Lawrence Carey, Lyle Linsemier, Jon Quisler, James Robinson, Stephen Rodock, and Gregory Thoen, Soil Conservation Service, and Thomas Bauer and Craig Outwater, Michigan Department of Agriculture

United States Department of Agriculture, Soil Conservation Service, in cooperation with Michigan Department of Agriculture, Michigan Agricultural Experiment Station, and Michigan Technological University

DICKINSON COUNTY is in the south-central part of the Upper Peninsula of Michigan. The county is bordered on the east by Menominee and Marquette Counties, on the north by Marquette County, on the west by Iron County, and on the south by Wisconsin. It has a total area of 497,548 acres, or about 777 square miles. The population was 25,341 in 1980.

Mining and lumbering dominated the early development of the survey area. The county currently has no active mines. The major economic activities are related to the growing of trees for lumber, pulpwood, and fuel. Recreation and tourism, potato and dairy farming, and several small industries also are important parts of the local economy.

General Nature of the County

This section gives general information concerning the county. It describes climate, physiography, and streams and lakes.

Climate

Prepared by the Michigan Department of Agriculture, Climatology Program, East Lansing, Michigan.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Iron Mountain and Crystal Falls. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 16.3 degrees F at Iron Mountain and 11.4 degrees at Crystal Falls, and the average daily minimum temperature is 6.5 degrees at Iron Mountain and 0 degrees at Crystal Falls. The lowest temperature on record is -39 degrees at Iron Mountain and -42 degrees at Crystal Falls. In summer the average temperature is 64.9 degrees at Iron Mountain and 61.9 degrees at Crystal Falls, and the average daily maximum temperature is 77.3 degrees at Iron Mountain and 75.5 degrees at Crystal Falls. The highest recorded temperature is 104 degrees at Iron Mountain and 99 degrees at Crystal Falls.

Growing degree days for Iron Mountain are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 30.36 inches at Iron Mountain and 29.77 inches at Crystal Falls. Of these totals, 21.02 inches at Iron Mountain and 20.30 inches at Crystal Falls usually fall in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16.8 inches at Iron Mountain and 16.7

inches at Crystal Falls. Thunderstorms occur on about 30 days each year, and most occur in June and July.

The average seasonal snowfall is 63.3 inches at Iron Mountain and 70.6 inches at Crystal Falls. The greatest snow depth at any one time during the period of record was 50 inches at Iron Mountain and 36 inches at Crystal Falls. On the average, 116 days of the year at Iron Mountain and 130 days at Crystal Falls have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year. The highest seasonal snowfall was 128.5 inches during the winter of 1938-39 at Iron Mountain and 118.1 inches during the winter of 1970-71 at Crystal Falls. The lowest seasonal snowfall was 27.3 inches during the winter of 1943-44 at Iron Mountain and 31.6 inches during the winter of 1963-64 at Crystal Falls. The highest monthly snowfall was 43.5 inches in January 1971 at Iron Mountain and 43.1 inches in December 1968 at Crystal Falls. The heaviest 1-day snowfall on record was 16 inches on February 23, 1922, at Iron Mountain and 14 inches on January 7, 1967, at Crystal Falls.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 85 percent. The sun shines 65 percent of the time possible in summer and 35 percent in winter. The prevailing wind is from the southwest (*3*).

Physiography

Dickinson County is part of a high plateau region. Elevation ranges from about 800 to 1,600 feet above sea level. The physiography of the county is the result of continental glaciation, modified in some areas by bedrock. The dominant features are moraines, till plains, and outwash plains.

The northern and eastern parts of the county occur as a complex system of moraines. These moraines are rolling and hilly, uneven areas that commonly have closed depressions, or kettles. Intermixed with the moraines are nearly level and undulating till plains and outwash plains. The outwash plains commonly have depressions, which formed when detached blocks of glacial ice buried in the outwash sediments melted.

Much of the topography of the southwestern part of the county is bedrock controlled. The Menominee Range, in the vicinity of Iron Mountain and Vulcan, is a high ridge of bedrock covered with a thin layer of glacial till. Other bedrock-controlled areas are in a complex system of low ridges and knobs, which generally are covered with till but which have many small rock outcrops. Intermixed with these bedrock-dominated areas are moraines, till plains, and outwash plains. The largest outwash area is in the southwest corner of the county, near the Menominee and Sturgeon Rivers.

Stream valleys are narrow to nearly a mile wide. Many of the streams are underfit. The streamflow is insufficient to account for the valley size.

Streams and Lakes

Dickinson County has five major drainage systems. These are the Michigamme River, the West Branch of the Escanaba River, the Ford River, the Sturgeon River, and the Menominee River. The Michigamme River flows across the northwestern part of the county. The West Branch of the Escanaba River drains the northeastern part. The Ford and Sturgeon Rivers and their many tributaries drain the central and southeastern parts. The Menominee River, the largest stream, is the southwestern boundary of the county.

Many small natural lakes are in the county. The largest are Lake Antoine and Fumee Lake, in the southwestern part of the county, and Sawyer Lake, in the northwestern part. There are several hydroelectric impoundments on the Menominee and Sturgeon Rivers and two large wildlife and recreational impoundments on the East Branch of the Sturgeon River (fig. 1).

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship,

Figure 1.—An impoundment on the East Branch of the Sturgeon River in an area of the Emmet-Carbondale-Cathro association.

are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management

were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures followed in making this survey are described in the National Soils Handbook and the *Soil Survey Manual* (*9*) of the Soil Conservation Service.

Before traversing the landscape, the soil scientists compared each map sheet to the USGS topographic map for the area and stereoscopically plotted preliminary boundaries of slopes and landforms on leaf-off aerial photographs. Some traverses were made by truck or trail bike on the existing network of roads and trails, but most were made on foot, at intervals of about one-fourth mile. Traverses or random observations were made at closer intervals in areas of high variability.

Soil examinations along the traverses were made wherever obvious soil boundaries were crossed. Observations of such items as landforms, blowndown trees, vegetation, roadbanks, and rock outcrops were made without regard to spacing. Soil boundaries were determined on the basis of soil examinations, observations of the landscape and vegetation, and photo interpretation. The soil material was examined with the aid of a hand auger or a spade to a depth of about 5 feet. The pedons described as typical were observed and studied in 3- by 4-foot excavations.

Samples for chemical and physical analyses were taken from the sites of the typical pedon for some of the major soils in the survey area. The analyses were made by the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan. The results of the analyses are stored in a computerized data file at the laboratory. The results and descriptions of the laboratory procedures can be obtained on request from the laboratory.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions, names, and delineations of the soils on the general soil map of this survey area do not fully match or agree with those of the soils on older maps of adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in concepts of soil series, and variations in the intensity of mapping or in the extent of the soils in the survey areas.

Soil Descriptions

Nearly Level to Hilly, Well Drained, Loamy Soils and Nearly Level, Very Poorly Drained, Organic Soils

1. Emmet-Carbondale-Cathro Association

Nearly level to hilly, well drained and very poorly drained, loamy and mucky soils that formed in glacial till and organic deposits

This association consists of soils on flats, hills, knolls, ridges, and depressions on drumlins, moraines, and till plains and in drainageways. Slopes range from 0 to 35 percent.

This association makes up about 18 percent of the county. It is about 30 percent Emmet soils, 20 percent Carbondale soils, 15 percent Cathro soils, and 35 percent soils of minor extent.

Emmet soils are nearly level to hilly and are on flats, knolls, ridges, and hills in the uplands. They are well drained. Typically, the surface layer is black, friable loam about 2 inches thick. The subsurface layer is dark brown, friable fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is reddish brown, friable sandy loam. The lower part is reddish brown, friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam.

Carbondale soils are nearly level and are on low flats and in depressions and drainageways. They are very poorly drained. Typically, the surface layer is black, friable muck about 8 inches thick. Below this to a depth of about 60 inches are layers of black mucky peat and muck.

Cathro soils are nearly level and are in depressions and drainageways, on low flats, and near streams on flood plains. They are very poorly drained. Typically, the surface layer is black, friable muck about 8 inches thick. Below this is dark reddish brown muck about 35 inches thick. The substratum to a depth of about 60 inches is brown very fine sandy loam and stratified fine sandy loam and loamy sand.

Of minor extent in this association are the well drained Escanaba and Nadeau soils and the somewhat poorly drained Solona and Wainola soils. Escanaba and Nadeau soils are coarser textured than the Emmet soils. Escanaba soils are generally on foot slopes. Nadeau soils are in landscape positions similar to those of the Emmet soils. Solona and Wainola soils are on low flats and in depressions and drainageways.

This association is used mainly as woodland. The major management concerns are the erosion hazard, the equipment limitation, and the windthrow hazard. Some areas of the Emmet soils are cultivated. The major concerns in managing these areas are water erosion, soil blowing, and tilth.

2. Pemene-Emmet-Cathro Association

Nearly level to hilly, well drained and very poorly drained, loamy and mucky soils that formed in ice-contact drift, glacial till, and organic deposits

This association consists of soils on moraines and till plains. Slopes range from 0 to 35 percent.

This association makes up about 52 percent of the county. It is about 30 percent Pemene soils, 25 percent Emmet soils, 20 percent Cathro soils, and 25 percent soils of minor extent.

Pemene soils are nearly level to hilly and are on flats, knolls, ridges, and hills in the uplands. They are well drained. Typically, the surface layer is black, very friable fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray, very friable fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam.

Emmet soils are nearly level to hilly and are on flats, knolls, ridges, and hills in the uplands. They are well drained. Typically, the surface layer is black, friable loam about 2 inches thick. The subsurface layer is dark brown, friable fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is reddish brown, friable sandy loam. The lower part is reddish brown, friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam.

Cathro soils are nearly level and are in depressions and drainageways, on low flats, and near streams on flood plains. They are very poorly drained. Typically, the surface layer is black, friable muck about 8 inches thick. Below this is dark reddish brown muck about 35 inches thick. The substratum to a depth of about 60 inches is brown very fine sandy loam and stratified fine sandy loam and loamy sand.

Of minor extent in this association are the sandy, excessively drained Zimmerman soils; the sandy, somewhat excessively drained Karlin and Mancelona soils; the sandy, well drained and moderately well drained Rousseau soils; and the somewhat poorly drained Solona and Wainola soils. Zimmerman, Karlin, Mancelona, and Rousseau soils are generally on foot slopes and broad flats and in valleys. Solona and Wainola soils are on low flats and in depressions and drainageways.

This association is used mainly as woodland. Seedling mortality, the erosion hazard, the equipment limitation, and the windthrow hazard are management concerns. Some areas of the Pemene and Emmet soils are cultivated. The major concerns in managing these areas are droughtiness, water erosion, soil blowing, and tilth.

Rock Outcrop and Gently Rolling to Hilly, Well Drained, Loamy Soils

3. Pemene-Emmet-Rock Outcrop Association

Rock outcrop and gently rolling to hilly, well drained, loamy soils that formed in ice-contact drift and glacial till

This association is on bedrock-controlled moraines and till plains. The major soils are on ridges and hills. Slopes range from 6 to 35 percent.

This association makes up about 13 percent of the county. It is about 30 percent Pemene soils, 25 percent Emmet soils, 15 percent Rock outcrop, and 30 percent soils of minor extent.

Typically, the surface layer of the Pemene soils is black, very friable fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray, very friable fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam.

Typically, the surface layer of the Emmet soils is black, friable loam about 2 inches thick. The subsurface layer is dark brown, friable fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is reddish brown, friable sandy loam. The lower part is reddish brown, friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam.

Of minor extent in this association are the sandy, excessively drained Zimmerman soils; the sandy, somewhat excessively drained Mancelona soils; the sandy, well drained and moderately well drained Rousseau soils; the poorly drained Ensley soils; and the very poorly drained Cathro soils. Zimmerman, Mancelona, and Rousseau soils are generally on foot slopes and broad flats and in valleys. Ensley and Cathro soils are in depressions and drainageways and on low flats.

This association is used mainly as woodland. The major management concerns are seedling mortality, the erosion hazard, and the equipment limitation. The slope and the Rock outcrop hinder the use of equipment.

Nearly Level to Rolling, Well Drained to Excessively Drained, Loamy and Sandy Soils

4. Oconto-Mancelona-Karlin Association

Nearly level to rolling, well drained and somewhat excessively drained, loamy and sandy soils that formed in glacial drift and outwash

This association consists of soils on outwash plains. The major soils are on flats, knolls, foot slopes, side slopes, and ridges. Slopes range from 0 to 18 percent.

This association makes up about 2 percent of the county. It is about 40 percent Oconto and similar soils, 20 percent Mancelona soils, 15 percent Karlin soils, and 25 percent soils of minor extent.

Oconto soils are well drained. Typically, the surface layer is dark brown, friable fine sandy loam about 3 inches thick. The subsoil is about 35 inches thick. The upper part is dark brown, friable very fine sandy loam and strong brown, friable fine sandy loam. The next part

is reddish brown loam and brown sandy loam. The lower part is dark brown loamy sand. The substratum to a depth of about 60 inches is light yellowish brown gravelly sand.

Mancelona soils are somewhat excessively drained. Typically, the surface layer is black, very friable loamy sand about 1 inch thick. The subsurface layer is brown, loose loamy sand about 2 inches thick. The subsoil is about 28 inches thick. The upper part is strong brown, very friable loamy sand and loose sand. The lower part is dark brown, friable gravelly loamy sand. The substratum to a depth of about 60 inches is strong brown very gravelly coarse sand.

Karlin soils are somewhat excessively drained. Typically, the surface layer is black, very friable loamy fine sand about 2 inches thick. The subsurface layer is pinkish gray, very friable loamy fine sand about 2 inches thick. The subsoil is about 27 inches thick. The upper part is yellowish red, strong brown, and brown, friable and very friable loamy fine sand. The lower part is strong brown, very friable loamy sand. The substratum to a depth of about 60 inches is brown sand that has thin bands of strong brown loamy sand.

Of minor extent in this association are the well drained Emmet, Pence, and Pemene soils; the somewhat poorly drained Channing and Wainola soils; the poorly drained Deford soils; and the very poorly drained Cathro soils. Emmet soils have a loamy substratum. Pence soils are loamy in the upper part and are underlain by acid sand and gravel. Pemene soils are loamy fine sand in the lower part. Emmet and Pemene soils are generally on the crest and sides of knolls, ridges, and hills. Pence soils are on flats, knolls, and ridges. Channing, Wainola, Deford, and Cathro soils are in depressions and drainageways and on low flats.

This association is used mainly as woodland. The major management concern is seedling mortality. Some areas are cultivated. The major concerns in managing these areas are droughtiness, water erosion, soil blowing, the organic matter content, and tilth.

5. Pence-Vilas Association

Nearly level to rolling, well drained and excessively drained, loamy and sandy soils that formed in glacial drift and outwash

This association consists of soils on outwash plains. The major soils are on flats, knolls, foot slopes, side slopes, and ridges. Slopes range from 0 to 18 percent.

This association makes up about 4 percent of the county. It is about 40 percent Pence soils, 25 percent Vilas soils, and 35 percent soils of minor extent.

Pence soils are well drained. Typically, the surface layer is dark reddish brown, friable fine sandy loam about 4 inches thick. The subsoil is about 23 inches thick. The upper part is reddish brown, friable fine sandy loam. The next part is yellowish red, very friable sandy loam. The lower part is yellowish red, loose loamy sand and gravelly loamy sand. The substratum to a depth of about 60 inches is dark brown sand and brown gravelly sand.

Vilas soils are excessively drained. Typically, the surface layer is black, very friable loamy sand about 3 inches thick. The subsoil is about 31 inches thick. The upper part is dark brown and strong brown, very friable and loose loamy sand. The lower part is strong brown, loose sand. The substratum to a depth of about 60 inches is brown and light brown sand.

Of minor extent in this association are the well drained Oconto, Emmet, and Pemene soils; the somewhat poorly drained Channing soils; the poorly drained Deford soils; and the very poorly drained Cathro soils. Oconto, Emmet, and Pemene soils are finer textured than the Vilas soils. Oconto soils are in landscape positions similar to those of the Pence and Vilas soils. Emmet and Pemene soils are generally on the crest and sides of knolls, ridges, and hills. Channing, Deford, and Cathro soils are in depressions and drainageways and on low flats.

This association is used mainly as woodland. The major management concern is seedling mortality. Some areas are cultivated (fig. 2). The major concerns in managing these areas are droughtiness, water erosion, soil blowing, the organic matter content, and tilth.

Nearly Level to Rolling, Somewhat Excessively Drained and Excessively Drained, Sandy Soils

6. Mancelona-Rubicon Association

Nearly level to rolling, somewhat excessively drained and excessively drained, sandy soils that formed in glacial outwash

This association consists of soils on outwash plains. The major soils are on flats, knolls, foot slopes, side slopes, and ridges. Slopes range from 0 to 18 percent.

This association makes up about 2 percent of the county. It is about 35 percent Mancelona soils, 30 percent Rubicon soils, and 35 percent soils of minor extent.

Mancelona soils are somewhat excessively drained. Typically, the surface layer is black, very friable loamy sand about 1 inch thick. The subsurface layer is brown, loose loamy sand about 2 inches thick. The subsoil is about 28 inches thick. The upper part is strong brown, very friable loamy sand and loose sand. The lower part is dark brown, friable gravelly loamy sand. The substratum to a depth of about 60 inches is strong brown very gravelly coarse sand.

Rubicon soils are excessively drained. Typically, the surface layer is dark reddish brown, very friable loamy sand about 2 inches thick. The subsurface layer is pinkish gray, very friable sand about 3 inches thick. The subsoil is sand about 36 inches thick. The upper part is dark brown and very friable, and the lower part is strong

Figure 2.—An area of the Pence-Vilas association used as cropland. The impoundment on the small stream is used as a source of irrigation water.

brown and loose. The substratum to a depth of about 60 inches is strong brown sand.

Of minor extent in this association are the well drained Pemene and Oconto soils, the somewhat poorly drained Wainola and Channing soils, and the very poorly drained Cathro soils. Pemene and Oconto soils are finer textured than the major soils. Pemene soils are generally on the crest and sides of knolls, ridges, and hills. Oconto soils are in landscape positions similar to those of the major soils. Wainola, Channing, and Cathro soils are in depressions and drainageways and on low flats.

This association is used mainly as woodland. The major management concern is seedling mortality. Some areas of the Mancelona soils are cultivated. The major concerns in managing these areas are droughtiness, water erosion, soil blowing, and the organic matter content.

Nearly Level to Hilly, Excessively Drained and Well Drained, Sandy Soils and Nearly Level, Very Poorly Drained, Organic Soils

7. Rubicon-Cathro Association

Nearly level to rolling, excessively drained and very poorly drained, sandy and mucky soils that formed in glacial outwash and organic deposits

This association consists of soils on outwash plains. Slopes range from 0 to 18 percent.

This association makes up about 2 percent of the county. It is about 65 percent Rubicon soils, 20 percent Cathro soils, and 15 percent soils of minor extent.

Rubicon soils are nearly level to rolling and are on flats, knolls, foot slopes, side slopes, and ridges. They are excessively drained. Typically, the surface layer is

dark reddish brown, very friable loamy sand about 2 inches thick. The subsurface layer is pinkish gray, very friable sand about 3 inches thick. The subsoil is sand about 36 inches thick. The upper part is dark brown and very friable, and the lower part is strong brown and loose. The substratum to a depth of about 60 inches is strong brown sand.

Cathro soils are nearly level and are in depressions and drainageways, on low flats, and near streams on flood plains. They are very poorly drained. Typically, the surface layer is black, friable muck about 8 inches thick. Below this is dark reddish brown muck about 35 inches thick. The substratum to a depth of about 60 inches is brown very fine sandy loam and stratified fine sandy loam and loamy sand.

Of minor extent in this association are the well drained Pemene soils and the somewhat poorly drained Wainola soils. Pemene soils are finer textured than the Rubicon soils. They are on the crest and sides of knolls, ridges, and hills. Wainola soils are in depressions and drainageways and on low flats.

This association is used mainly as woodland. The major management concerns are seedling mortality, the equipment limitation, and the windthrow hazard.

8. Zimmerman-Cathro-Rousseau Association

Nearly level to hilly, excessively drained, very poorly drained, and well drained, sandy and mucky soils that formed in glacial drift, glacial outwash, and eolian and organic deposits

This association consists of soils on moraines and outwash plains. Slopes range from 0 to 35 percent.

This association makes up about 7 percent of the county. It is about 40 percent Zimmerman and similar soils, 20 percent Cathro soils, 20 percent Rousseau soils, and 20 percent soils of minor extent.

Zimmerman soils are nearly level to hilly and are on flats, knolls, ridges, and hills. They are excessively drained. Typically, the surface layer is black, very friable fine sand about 3 inches thick. The subsoil is about 57 inches thick. The upper part is brown, very friable fine sand. The next layer is reddish yellow and yellowish brown fine sand. The lower part is reddish yellow fine sand that has thin bands of dark brown loamy fine sand.

Cathro soils are nearly level and are in depressions and drainageways, on low flats, and near streams on flood plains. They are very poorly drained. Typically, the surface layer is black, friable muck about 8 inches thick. Below this is dark reddish brown muck about 35 inches thick. The substratum to a depth of about 60 inches is brown very fine sandy loam and stratified fine sandy loam and loamy sand.

Rousseau soils are nearly level to rolling and are on flats, knolls, foot slopes, side slopes, and ridges. They are well drained. Typically, the surface layer is light brownish gray, very friable fine sand about 6 inches thick. The subsoil is fine sand about 25 inches thick. The upper part is dark brown and very friable, and the lower part is brown and loose. The substratum to a depth of about 60 inches is light brown fine sand.

Of minor extent in this association are the well drained Karlin and Pemene soils and the somewhat poorly drained Wainola and Solona soils. Karlin and Pemene soils are finer textured than the Zimmerman and Rousseau soils. They are in landscape positions similar to those of the Zimmerman soils. Wainola and Solona soils are on low flats and in depressions and drainageways.

This association is used mainly as woodland. The erosion hazard, seedling mortality, the equipment limitation, and the windthrow hazard are management concerns.

Broad Land Use Considerations

Woodland

More than 90 percent of the acreage in Dickinson County is forested. The sugar maple forest cover type is dominant on the Emmet soils in associations 1, 2, and 3. The sugar maple and aspen cover types are dominant on the Pemene and Oconto soils in associations 2, 3, and 4. The aspen and paper birch cover types are dominant on the Mancelona, Pence, Karlin, Zimmerman, and Rousseau soils in associations 4, 5, 6, and 8. The aspen and jack pine cover types are dominant on the Rubicon and Vilas soils in associations 5, 6, and 7. The northern white-cedar, balsam fir, black spruce, and tamarack cover types are dominant on the Carbondale and Cathro soils in associations 1, 2, 7, and 8.

The erosion hazard and the equipment limitation are the major management concerns on the hilly soils in associations 1, 2, 3, and 8. Seedling mortality is the major concern on the sandy soils in associations 4 through 8. The windthrow hazard and the equipment limitation are the major concerns on the mucky soils in associations 1, 2, 7, and 8.

Cropland

Cropland is concentrated in the areas of associations 1 and 2 in the southern and central parts of the county. The soils most commonly used for cultivated crops are the nearly level to rolling Emmet and Pemene soils. Some areas of the Pence, Vilas, and Mancelona soils in associations 5 and 6 also are used as cropland. The mucky soils in associations 1, 2, 7, and 8 generally are not cultivated because of wetness and a short growing season. Because of the Rock outcrop, cultivation is impractical in most areas of association 3. The Rubicon soils in associations 6 and 7 generally are unsuited to cultivated crops because of extreme droughtiness. The nearly level and undulating, mineral soils in associations 4 and 8 generally are suited to cultivated crops. The major concerns in managing the cropland in the county

are water erosion, soil blowing, droughtiness, the organic matter content, and tilth.

Recreation

The nearly level and undulating, mineral soils in associations 1, 2, 4, and 5 generally are suited to most intensive recreational uses, such as playgrounds, camp areas, picnic areas, and paths and trails. The Carbondale and Cathro soils in associations 1, 2, 7, and 8 generally are not suited to these uses because of ponding. The rolling soils in associations 1 through 5 generally are suited to camp areas, picnic areas, and paths and trails, but the slope is a limitation. The Rubicon, Zimmerman, and Rousseau soils in associations 6, 7, and 8 are severely limited as sites for intensive recreational uses because they have a sandy surface layer. The Mancelona soils in association 6 generally are suited to camp areas, picnic areas, and paths and trails, but the slope and the content of small stones are limitations.

Wildlife Habitat

The loamy and sandy soils in associations 1, 2, 3, 4, 5, 6, and 8 generally are suited to openland wildlife habitat. The loamy and sandy soils throughout the county generally are suited to woodland wildlife habitat. The mucky Carbondale and Cathro soils in associations 1, 2, 7, and 8 generally are suited to wetland wildlife habitat.

Urban Development

The nearly level to rolling Emmet and Pemene soils in associations 1, 2, and 3 generally are suited to building site development. The nearly level to rolling, sandy and loamy soils in associations 4 through 8 generally are suited to building site development but are severely limited as sites for septic tank absorption fields because of a poor filtering capacity. The Carbondale and Cathro soils in associations 1, 2, 7, and 8 are unsuited to building site development and septic tank absorption fields because of ponding.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Rubicon sand, 6 to 18 percent slopes, is a phase of the Rubicon series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. The Waucedah-Cathro complex is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Carbondale and Cathro mucks is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

The descriptions, names, and delineations of the soils on the detailed maps of this survey area do not fully agree or match with those of the soils on older maps of adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in concepts of soil series, and variations in the intensity of mapping or in the extent of the soils in the survey areas.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

10—Waucedah-Cathro complex. These are nearly level, very poorly drained soils in depressions on flood plains. Both soils are subject to ponding. Also, the Waucedah soil is frequently flooded. Areas are about 40 to 50 percent Waucedah soil and 30 to 40 percent Cathro soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Waucedah soil has a black surface layer. The upper part is muck about 6 inches thick, and the lower part is sandy loam about 5 inches thick. The substratum to a depth of about 60 inches is dark gray loam that has thin layers of sand and partially decomposed vegetation. Some areas are only rarely flooded.

Typically, the Cathro soil has a surface layer of black muck about 8 inches thick. Below this is dark reddish brown muck about 35 inches thick. The substratum to a depth of about 60 inches is brown very fine sandy loam and stratified fine sandy loam and loamy sand. In some areas the muck is more than 51 inches thick.

Included with these soils in mapping are small areas of the somewhat poorly drained Solona and Wainola soils and the well drained Emmet, Rousseau, and Pemene soils. These included soils are on isolated knolls and ridges and in transitional areas adjoining other map units. They make up 12 to 15 percent of the unit.

Permeability is moderate in the Waucedah soil. It is moderately slow to moderately rapid in the upper part of the Cathro soil and moderate or moderately slow in the lower part. The available water capacity is moderate in the Waucedah soil and high in the Cathro soil. Surface runoff is very slow or ponded on both soils. The Waucedah soil has a seasonal high water table as much as 2 feet above the surface for the entire year. The Cathro soil has one near or above the surface from fall to spring.

Most areas support wetland grasses, sedges, and scattered trees. These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are concerns in managing woodland. The soils are generally not suitable for the use of ordinary crawler tractors or rubber-tired skidders. Special harvesting equipment is needed. Access to the soils is easiest during periods in winter when access roads are frozen. Because of the wetness and the organic surface layer, loss of seedlings can be more than 50 percent. Because of the wetness, the trees on these soils are shallow rooted. Many may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can prevent or delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Because of the wetness, the flooding, seedling mortality, and plant competition, trees are not planted on these soils.

The woodland ordination symbol assigned to the Waucedah soil is 3W, and that assigned to the Cathro soil is 5W. The land capability classification is VIw. The Michigan soil management group assigned to the Waucedah soil is L-4c, and that assigned to the Cathro soil is M/3c. The primary habitat type is FMC-C, and the secondary habitat type is FMC.

13B—Pemene fine sandy loam, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam. In some places, the upper part of the soil is loamy fine sand and the lower part is fine sandy loam. In other places the soil is dominantly fine sandy loam and loam. In some areas it is moderately well drained. In other areas it is cobbly or stony.

Included with this soil in mapping are small areas of Zimmerman, Mancelona, and Karlin soils. These soils are coarser textured than the Pemene soil. They are mainly on foot slopes and in valleys. Also included are small areas of the somewhat poorly drained Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate or moderately rapid in the Pemene soil. The available water capacity is moderate. Surface runoff is slow.

Most areas of this soil are used as woodland (fig. 3). No major hazards or limitations affect planting or harvesting in the wooded areas.

If this soil is cultivated, the major management concerns are droughtiness, soil blowing, and tilth. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface increases the supply of soil moisture by increasing the rate of water infiltration. It also helps to prevent crusting during periods of heavy rainfall. If enough irrigation water is available, the soil can be irrigated. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 4S. The land capability classification is IIIs. The Michigan soil management group is 3a. The primary habitat type is TM, and the secondary habitat type is ATD.

13D—Pemene fine sandy loam, 6 to 18 percent slopes. This gently rolling and rolling, well drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin

Figure 3.—A wooded area of Pemene fine sandy loam, 0 to 6 percent slopes. Aspen has been cut for pulpwood.

bands of reddish brown fine sandy loam. In places, the upper part of the soil is loamy fine sand and the lower part is fine sandy loam. In some areas the soil is dominantly fine sandy loam and loam. In other areas it is cobbly or stony.

Included with this soil in mapping are small areas of Zimmerman, Mancelona, and Karlin soils. These soils are coarser textured than the Pemene soil. They are mainly on foot slopes and in valleys. Also included are small areas of the somewhat poorly drained Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 percent of the unit.

Permeability is moderate or moderately rapid in the Pemene soil. The available water capacity is moderate. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concern is the equipment limitation on landings. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, droughtiness, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing, conserves moisture, and helps

to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 4S. The land capability classification is IVe. The Michigan soil management group is 3a. The primary habitat type is TM, and the secondary habitat type is ATD.

13F—Pemene fine sandy loam, 18 to 35 percent slopes. This hilly, well drained soil is on hills and ridges in the uplands.

Typically, the surface layer is black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam. In places, the upper part of the soil is loamy fine sand and the lower part is fine sandy loam. In some areas the soil is dominantly fine sandy loam and loam. In other areas it is cobbly or stony.

Included with this soil in mapping are small areas of Zimmerman, Mancelona, and Karlin soils. These soils are coarser textured than the Pemene soil. They are mainly on foot slopes and in valleys. Also included are small areas of the somewhat poorly drained Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 8 to 12 percent of the unit.

Permeability is moderate or moderately rapid in the Pemene soil. The available water capacity is moderate. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and the erosion hazard. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible. In a few areas rock outcrops hinder road construction. Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

This soil is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol is 4R. The land capability classification is VIIe. The Michigan soil management group is 3a. The primary habitat type is TM, and the secondary habitat type is ATD.

14B—Fence very fine sandy loam, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on stream terraces and upland flats.

Typically, the surface layer is black very fine sandy loam about 6 inches thick. The subsurface layer is brown very fine sandy loam about 2 inches thick. The subsoil is about 40 inches thick. The upper part is dark brown, friable very fine sandy loam. The next part is brown silt loam. The lower part is brown loamy very fine sand that has thin bands of very fine sandy loam. The substratum to a depth of about 60 inches is brown, stratified loamy very fine sand and very fine sandy loam. In some areas the soil is dominantly fine sandy loam and loam and is only slightly stratified. In other areas it has a higher content of clay throughout. In some places the substratum is moderately alkaline. In other places the soil is moderately well drained.

Included with this soil in mapping are scattered small areas of Karlin, Mancelona, and Pemene soils. These soils are coarser textured than the Fence soil. They are in landscape positions similar to those of the Fence soil. Also included are small areas of the somewhat poorly drained Alstad and Solona soils in depressions and drainageways. Included soils make up about 10 to 12 percent of the unit.

Permeability is moderately slow in the Fence soil. The available water capacity is high. Surface runoff is slow.

About half of the acreage of this soil is woodland. The equipment limitation is generally slight, but the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the

cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3A. The land capability classification is IIe. The Michigan soil management group is 2.5a. The primary habitat type is AVO, and the secondary habitat type is AOC.

14D—Fence very fine sandy loam, 6 to 18 percent slopes. This gently rolling and rolling, well drained soil is on side slopes.

Typically, the surface layer is black very fine sandy loam about 6 inches thick. The subsurface layer is brown very fine sandy loam about 2 inches thick. The subsoil is about 40 inches thick. The upper part is dark brown, friable very fine sandy loam. The next part is brown silt loam. The lower part is brown loamy very fine sand that has thin bands of very fine sandy loam. The substratum to a depth of about 60 inches is brown, stratified loamy very fine sand and very fine sandy loam. In some areas the soil is dominantly fine sandy loam and loam and is only slightly stratified. In other areas it has a higher content of clay throughout. In places the substratum is moderately alkaline.

Included with this soil in mapping are scattered small areas of Pemene and Oconto soils. These soils are in landscape positions similar to those of the Fence soil. Pemene soils are coarser textured than the Fence soil. Oconto soils have gravelly sand in the substratum. Also included are small areas of the somewhat poorly drained Alstad, poorly drained Deford, and very poorly drained Cathro soils in depressions and drainageways. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderately slow in the Fence soil. The available water capacity is high. Surface runoff is medium.

Most areas of this soil are used as woodland. The equipment limitation is generally slight but is severe on landing sites. Also, the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3A. The land capability classification is IVe. The Michigan soil management group is 2.5a. The primary habitat type is AVO, and the secondary habitat type is AOC.

15—Carbondale and Cathro mucks. These are nearly level, very poorly drained soils on low flats and in depressions and drainageways. Both soils are subject to ponding. Areas are 0 to 80 percent Carbondale soil and 10 to 80 percent Cathro soil. The two soils are used and managed so similarly that separating them in mapping was not practical.

Typically, the Carbondale soil has a surface layer of black muck about 8 inches thick. Below this to a depth of about 60 inches are layers of black mucky peat and muck. In places the organic material is strongly acid to extremely acid.

Typically, the Cathro soil has a surface layer of black muck about 8 inches thick. Below this is dark reddish brown muck about 35 inches thick. The substratum to a depth of about 60 inches is brown, stratified very fine sandy loam, fine sandy loam, and loamy sand. In some areas the soil is poorly drained and has less than 16 inches of muck. In other areas the organic material is strongly acid to extremely acid.

Included with these soils in mapping are small areas of the somewhat poorly drained Solona and Wainola soils, the moderately well drained Rousseau soils, and the well drained Emmet and Pemene soils. These included soils are on isolated knolls and ridges and in transitional areas adjoining other map units. Also included are some areas that have a few rock outcrops. Included areas make up about 20 to 25 percent of the unit.

Permeability is moderately slow to moderately rapid in the Carbondale soil. It is moderately slow to moderately rapid in the upper part of the Cathro soil and moderate or moderately slow in the lower part. The available water capacity is high in both soils. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from fall to spring.

These soils are used as woodland. The equipment limitation, seedling mortality, and the windthrow hazard are management concerns. The soils are generally not suitable for the use of ordinary crawler tractors or rubber-tired skidders. Special harvesting equipment is needed. Access to the soils is easiest during periods in winter when access roads are frozen. Because of the wetness and the organic surface layer, loss of seedlings can be more than 50 percent. Trees generally are not planted on these soils because of wetness, seedling

mortality, and low productivity. Because of the wetness, the trees on these soils are shallow rooted. Many may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

The woodland ordination symbol is 5W. The land capability classification is VIw. The Michigan soil management group assigned to the Carbondale soil is Mc, and that assigned to the Cathro soil is M/3c. The primary habitat type is TTM, and the secondary habitat type is TTS.

17—Greenwood and Dawson peats. These are nearly level, very poorly drained soils on low flats and in depressions. Both soils are subject to ponding. Areas are 0 to 70 percent Greenwood soil and 10 to 80 percent Dawson soil. The two soils are used and managed so similarly that separating them in mapping was not practical.

Typically, the Greenwood soil has a surface layer of dark brown peat about 6 inches thick. Below this to a depth of about 60 inches is very dark grayish brown and very dark brown peaty muck. In places the organic material is less acid.

Typically, the Dawson soil has a surface layer of brown peat about 8 inches thick. Below this is about 22 inches of dark brown and black mucky peat and muck. The substratum to a depth of about 60 inches is pale brown and dark brown fine sand and loamy fine sand. In some areas the organic material is less than 16 inches thick. In other areas it is less acid.

Included with these soils in mapping are small areas of the somewhat poorly drained Solona and Wainola soils, the moderately well drained and well drained Rousseau soils, and the well drained Pemene soils. These included soils are on isolated knolls and ridges and in transitional areas adjoining other map units. They make up about 20 to 25 percent of the unit.

Permeability is moderate or moderately rapid in the Greenwood soil. It is moderately slow to moderately rapid in the upper part of the Dawson soil and rapid in the lower part. The available water capacity is high in both soils. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from fall to spring.

Most areas support sedges, low shrubs, and scattered trees. Many areas are relatively open bogs. Most of the trees in these areas grow near the edges of the bogs. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are concerns in managing woodland. The soils generally are not suitable for the use of ordinary crawler tractors or rubber-tired skidders. Special harvesting equipment is needed. Access to the soils is easiest during periods in winter when access roads are frozen.

Because of the wetness and the organic surface layer, loss of tree seedlings can be more than 50 percent. Because of the wetness, the trees on these soils are shallow rooted. Many may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Because of the wetness, severe seedling mortality, and plant competition, trees are not planted on these soils.

The woodland ordination symbol is 2W. The land capability classification is VIIw. The Michigan soil management group is Mc-a. The primary habitat type is PCS.

20B—Karlin loamy fine sand, 0 to 6 percent slopes. This nearly level and undulating, somewhat excessively drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is black loamy fine sand about 2 inches thick. The subsurface layer is pinkish gray loamy fine sand about 2 inches thick. The subsoil is about 27 inches thick. The upper part is yellowish red, strong brown, and brown, friable and very friable loamy fine sand, and the lower part is strong brown, very friable loamy sand. The substratum to a depth of about 60 inches is brown sand that has thin bands of strong brown loamy sand. In some places the substratum is gravelly sand. In other places the upper part of the soil is loamy sand. In some areas the soil is dominantly fine sand or is fine sand that has bands of loamy fine sand in the substratum. In other areas the soil is moderately well drained.

Included with this soil in mapping are scattered small areas of Rubicon and Pemene soils. These soils are in landscape positions similar to those of the Karlin soil. Rubicon soils are coarser textured than the Karlin soil, and Pemene soils are finer textured. Also included are small areas of the somewhat poorly drained Wainola and Channing soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 8 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Karlin soil and rapid in the lower part. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concern is seedling mortality. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are droughtiness, the organic matter content, and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that

leaves crop residue on the surface increases the moisture supply by increasing the rate of water infiltration. If enough irrigation water is available, the soil can be irrigated. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3S. The land capability classification is IIIs. The Michigan soil management group is 4a. The primary habitat type is TM, and the secondary habitat type is TMV.

20D—Karlin loamy fine sand, 6 to 18 percent slopes. This gently rolling and rolling, somewhat excessively drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is black loamy fine sand about 2 inches thick. The subsurface layer is pinkish gray loamy fine sand about 2 inches thick. The subsoil is about 27 inches thick. The upper part is yellowish red, strong brown, and brown, friable and very friable loamy fine sand, and the lower part is strong brown, very friable loamy sand. The substratum to a depth of about 60 inches is brown sand that has thin bands of strong brown loamy sand. In some places the substratum is gravelly sand. In other places the upper part of the soil is loamy sand. In some areas the soil is dominantly fine sand or is fine sand that has bands of loamy fine sand in the substratum.

Included with this soil in mapping are scattered small areas of Rubicon and Pemene soils. These soils are in landscape positions similar to those of the Karlin soil. Rubicon soils are coarser textured than the Karlin soil, and Pemene soils are finer textured. Also included are small areas of the somewhat poorly drained Wainola and Channing, poorly drained Deford, and very poorly drained Cathro soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Karlin soil and rapid in the lower part. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are seedling mortality and the equipment limitation on landings. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, droughtiness, and the organic matter content. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Field windbreaks, buffer strips, and cover crops, such as rye, help to control blowing.

The woodland ordination symbol is 3S. The land capability classification is IVe. The Michigan soil management group is 4a. The primary habitat type is TM, and the secondary habitat type is TMV.

20F—Karlin loamy fine sand, 18 to 35 percent slopes. This hilly, somewhat excessively drained soil is on hills and ridges in the uplands.

Typically, the surface layer is black loamy fine sand about 2 inches thick. The subsurface layer is pinkish gray loamy fine sand about 2 inches thick. The subsoil is about 27 inches thick. The upper part is yellowish red, strong brown, and brown, friable and very friable loamy fine sand, and the lower part is strong brown, very friable loamy sand. The substratum to a depth of about 60 inches is brown sand that has thin bands of strong brown loamy sand. In some places the substratum is gravelly sand. In other places the upper part of the profile is loamy sand. In some areas the soil is dominantly fine sand or is fine sand that has bands of loamy fine sand in the substratum.

Included with this soil in mapping are scattered small areas of Rubicon and Pemene soils. These soils are in landscape positions similar to those of the Karlin soil. Rubicon soils are coarser textured than the Karlin soil, and Pemene soils are finer textured. Also included are small areas of the somewhat poorly drained Wainola and Channing, poorly drained Deford, and very poorly drained Cathro soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Karlin soil and rapid in the lower part. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and seedling mortality. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying

out logging roads and in operating the equipment. The roads should be designed so that they conform to topography, and the grade should be kept as low as possible. In a few areas rock outcrops hinder road construction.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol is 3R. The land capability classification is VIIe. The Michigan soil management group is 4a. The primary habitat type is TM, and the secondary habitat is TMV.

23B—Escanaba loamy fine sand, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is black loamy fine sand about 2 inches thick. The subsurface layer is reddish gray loamy fine sand about 4 inches thick. The subsoil is about 40 inches thick. The upper part is dark reddish brown and reddish brown, very friable loamy fine sand. The next part is reddish brown loamy fine sand and dark reddish brown fine sandy loam. The lower part is dark reddish brown, friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown fine sandy loam. In some places it is loamy fine sand. In other places the soil is moderately well drained.

Included with this soil in mapping are scattered small areas of Rousseau, Emmet, and Karlin soils. These soils are in landscape positions similar to those of the Escanaba soil. Rousseau soils are fine sand throughout. Emmet soils are finer textured in the upper part of the subsoil than the Escanaba soil. Karlin soils are underlain by sand. Also included are small areas of the somewhat poorly drained Solona and Wainola and poorly drained Ensley soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 5 to 12 percent of the unit.

Permeability is moderately rapid in the upper part of the Escanaba soil and moderate in the lower part. The available water capacity is moderate. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concern is seedling mortality. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are the moderate available water capacity, the organic matter content, and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface increases the moisture supply by increasing the rate of water infiltration. The soil can be irrigated if enough irrigation water is available. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3S. The land capability classification is IIIs. The Michigan soil management group is 4/2a. The primary habitat type is TM, and the secondary habitat type is AVO.

23D—Escanaba loamy fine sand, 6 to 18 percent slopes. This gently rolling and rolling, well drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is black loamy fine sand about 2 inches thick. The subsurface layer is reddish gray loamy fine sand about 4 inches thick. The subsoil is about 40 inches thick. The upper part is dark reddish brown and reddish brown, very friable loamy fine sand. The next part is reddish brown loamy fine sand and dark reddish brown fine sandy loam. The lower part is dark reddish brown, friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown fine sandy loam. In places it is loamy fine sand.

Included with this soil in mapping are scattered small areas of Rousseau, Emmet, and Karlin soils. These soils are in landscape positions similar to those of the Escanaba soil. Rousseau soils are fine sand throughout. Emmet soils are finer textured in the upper part of the subsoil than the Escanaba soil. Karlin soils are underlain by sand. Also included are small areas of the somewhat poorly drained Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 12 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Escanaba soil and moderate in the lower part. The available water capacity is moderate. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment

limitation on landings and seedling mortality. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils. Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are water erosion and soil blowing, the moderate available water capacity, and the organic matter content. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3S. The land capability classification is IVe. The Michigan soil management group is 4/2a. The primary habitat type is TM, and the secondary habitat type is AVO.

24B—Emmet fine sandy loam, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is black loam about 2 inches thick. The subsurface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is reddish brown, friable sandy loam. The lower part is reddish brown, friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam. In some places it is loamy fine sand. In other places the soil is moderately well drained. In some areas the surface layer is cobbly or stony.

Included with this soil in mapping are small areas of Escanaba and Rousseau soils. These soils are coarser textured than the Emmet soil. They generally are on foot slopes and in valleys. Also included are small areas of Nadeau, Solona, Ensley, and Cathro soils and some areas that have a few rock outcrops. Nadeau soils have sand, gravel, and cobbles in the substratum. They are mainly on narrow, steep-sided ridges and are most common in the southeastern part of the county. The somewhat poorly drained Solona, poorly drained Ensley, and very poorly drained Cathro soils are in depressions and drainageways. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the Emmet soil. The available water capacity also is moderate. Surface runoff is slow.

Most areas of this soil are used as woodland (fig. 4). The equipment limitation is generally slight, but the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, and tilth (fig. 5). Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage helps to control water erosion and soil blowing and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3A. The land capability classification is IIe. The Michigan soil management group is 3a. The primary habitat type is AVO, and the secondary habitat type is AVO-A.

24D—Emmet fine sandy loam, 6 to 18 percent slopes. This gently rolling and rolling, well drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is black loam about 2 inches thick. The subsurface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is reddish brown, friable sandy loam. The lower part is reddish brown, friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam. In some places it is loamy fine sand. In other places the surface layer is cobbly or stony.

Included with this soil in mapping are small areas of Escanaba and Rousseau soils. These soils are coarser textured than the Emmet soil. They generally are on foot slopes and in valleys. Also included are small areas of Nadeau, Solona, Wainola, Ensley, and Cathro soils and some areas that have a few rock outcrops. Nadeau soils have sand, gravel, and cobbles in the substratum. They are mainly on narrow, steep-sided ridges and are most common in the southeastern part of the county. The somewhat poorly drained Solona and Wainola, poorly

Figure 4.—Young stand of northern hardwoods on Emmet fine sandy loam, 0 to 6 percent slopes.

drained Ensley, and very poorly drained Cathro soils are in depressions and drainageways. Included areas make up about 12 to 15 percent of the unit.

Permeability is moderate in the Emmet soil. The available water capacity also is moderate. Surface runoff is medium.

Most areas of this soil are used as woodland. The equipment limitation is generally slight but is severe on landing sites. Also, the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3A. The land capability classification is IVe. The Michigan soil

Figure 5.—Potatoes in an area of Emmet fine sandy loam, 0 to 6 percent slopes.

management group is 3a. The primary habitat type is AVO, and the secondary habitat type is AVO-A.

24F—Emmet fine sandy loam, 18 to 35 percent slopes. This hilly, well drained soil is on hills and ridges in the uplands.

Typically, the surface layer is black loam about 2 inches thick. The subsurface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is reddish brown, friable sandy loam. The lower part is reddish brown, friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam. In some places it is loamy fine sand. In other places the surface layer is cobbly or stony.

Included with this soil in mapping are small areas of Escanaba and Rousseau soils. These soils are coarser textured than the Emmet soil. They generally are on foot slopes and in valleys. Also included are small areas of Nadeau, Solona, Ensley, Deford, and Cathro soils and some areas that have a few rock outcrops. Nadeau soils have sand, gravel, and cobbles in the substratum. They are mainly on narrow, steep-sided ridges and are most common in the southeastern part of the county. The somewhat poorly drained Solona, poorly drained Ensley and Deford, and very poorly drained Cathro soils are in depressions and drainageways. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the Emmet soil. The available water capacity also is moderate. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and the erosion hazard. The slope limits the

use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible. In a few areas rock outcrops hinder road construction. The use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

This soil is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol is 3R. The land capability classification is VIIe. The Michigan soil management group is 3a. The primary habitat type is AVO, and the secondary habitat type is AVO-A.

25B—Pence fine sandy loam, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats and knolls in the uplands.

Typically, the surface layer is dark reddish brown fine sandy loam about 4 inches thick. The subsoil is about 23 inches thick. The upper part is reddish brown, friable fine sandy loam. The next part is yellowish red, very friable sandy loam. The lower part is yellowish red, loose loamy sand and gravelly loamy sand. The substratum to a depth of about 60 inches is dark brown sand and brown gravelly sand. In some places the upper part of the subsoil is loamy sand or loamy fine sand. In other places the substratum is moderately alkaline. In some areas the soil is moderately well drained.

Included with this soil in mapping are scattered small areas of Oconto, Pemene, and Zimmerman soils. These soils are in landscape positions similar to those of the Pence soil. Oconto and Pemene soils have a subsoil that is thicker than that of the Pence soil, and Zimmerman soils are coarser textured. Also included are small areas of the somewhat poorly drained Channing and Solona soils in depressions and drainageways. Included soils make up about 7 to 10 percent of the unit.

Permeability is moderately rapid in the upper part of the Pence soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concern is seedling mortality. Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, the low available water capacity, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing, increases the moisture supply by increasing the rate of water infiltration, and helps to prevent crusting during periods of heavy rainfall. The soil can be irrigated if enough irrigation water is available. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 7S. The land capability classification is IIIe. The Michigan soil management group is 4a-a. The primary habitat type is TMV, and the secondary habitat type is TM.

25D—Pence fine sandy loam, 6 to 18 percent slopes. This gently rolling and rolling, well drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is dark reddish brown fine sandy loam about 4 inches thick. The subsoil is about 23 inches thick. The upper part is reddish brown, friable fine sandy loam. The next part is yellowish red, very friable sandy loam. The lower part is yellowish red, loose loamy sand and gravelly loamy sand. The substratum to a depth of about 60 inches is dark brown sand and brown gravelly sand. In places the upper part of the subsoil is loamy sand or loamy fine sand. In some areas the substratum is sand. In other areas it is moderately alkaline.

Included with this soil in mapping are scattered small areas of Oconto, Pemene, and Zimmerman soils. These soils are in landscape positions similar to those of the Pence soil. Oconto and Pemene soils have a subsoil that is thicker than that of the Pence soil, and Zimmerman soils are coarser textured. Also included are small areas of the somewhat poorly drained Channing and Solona soils in depressions and drainageways. Included soils make up about 8 to 12 percent of the unit.

Permeability is moderately rapid in the upper part of the Pence soil and rapid or very rapid in the lower part.

The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation on landings and seedling mortality. Landing sites may be available in the small included or adjacent areas of nearly level or undulating soils. Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, the low available water capacity, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control erosion and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing, increases the moisture supply by increasing the rate of water infiltration, and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 7R. The land capability classification is IVe. The Michigan soil management group is 4a-a. The primary habitat type is TMV, and the secondary habitat type is TM.

25F—Pence fine sandy loam, 18 to 35 percent slopes. This hilly, well drained soil is on hills and ridges in the uplands.

Typically, the surface layer is dark reddish brown fine sandy loam about 4 inches thick. The subsoil is about 23 inches thick. The upper part is reddish brown, friable fine sandy loam. The next part is yellowish red, very friable sandy loam. The lower part is yellowish red, loose loamy sand and gravelly loamy sand. The substratum to a depth of about 60 inches is dark brown sand and brown gravelly sand. In places the upper part of the subsoil is loamy sand or loamy fine sand. In some areas the substratum is sand. In other areas it is moderately alkaline.

Included with this soil in mapping are scattered small areas of Oconto, Pemene, and Zimmerman soils. These soils are in landscape positions similar to those of the Pence soil. Oconto and Pemene soils have a subsoil that is thicker than that of the Pence soil, and Zimmerman soils are coarser textured. Also included are small areas of the somewhat poorly drained Channing and Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Pence soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and seedling mortality. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol is 7R. The land capability classification is VIIe. The Michigan soil management group is 4a-a. The primary habitat type is TMV, and the secondary habitat type is TM.

26—Deford fine sand. This nearly level, poorly drained soil is on low flats and in depressions and drainageways. It is subject to ponding.

Typically, the surface layer is black fine sand about 6 inches thick. The upper part of the substratum is grayish brown, mottled loamy fine sand. The lower part to a depth of about 60 inches is brown fine sand. In some places the soil has a dark reddish brown subsoil. In other places it has a subsoil that is very strongly acid or extremely acid in the upper part. In some areas the upper part of the soil is dominantly fine sandy loam. In other areas the surface layer is muck.

Included with this soil in mapping are small areas of the somewhat poorly drained Wainola and moderately well drained Rousseau soils. These soils are on isolated knolls in transitional areas adjoining other map units.

Also included are small areas of the very poorly drained Cathro soils in the slightly lower landscape positions. Included soils make up about 10 to 15 percent of the unit.

Permeability is rapid in the Deford soil. The available water capacity is low. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from fall to spring.

This soil is used as woodland. The major management concerns are the equipment limitation, seedling mortality, and the windthrow hazard. The seasonal high water table restricts the use of equipment in late fall and in winter and spring. The equipment should be used only when the soil is dry or frozen or has adequate snow cover. Because of the wetness, loss of seedlings can be more than 50 percent and the trees are shallow rooted. Many trees are blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Trees are not generally planted on this soil because of wetness and low productivity.

The woodland ordination symbol is 4W. The land capability classification is Vw. The Michigan soil management group is 4c. The primary habitat type is TTS, and the secondary habitat type is TTM.

32A—Rousseau fine sand, moderately wet, 0 to 3 percent slopes. This nearly level, moderately well drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is light brownish gray fine sand about 6 inches thick. The subsoil is fine sand about 25 inches thick. The upper part is dark brown and very friable, and the lower part is brown and loose. The substratum to a depth of about 60 inches is light brown, mottled fine sand. In some places the soil is dominantly sand. In other places it is well drained. In some areas the substratum is gravelly sand or has bands of loamy fine sand.

Included with this soil in mapping are scattered small areas of moderately well drained soils that have stratified fine sandy loam and loamy fine sand in the substratum. These soils are in landscape positions similar to those of the Rousseau soil. Also included are small areas of the poorly drained Deford soils in depressions and drainageways. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Rousseau soil. The available water capacity is low. Surface runoff is slow. The seasonal high water table is at a depth of 2.5 to 6.0 feet from fall to spring.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are droughtiness, the organic matter content, and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface increases the moisture supply by increasing the rate of water infiltration. If enough irrigation water is available, the soil can be irrigated. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 5S. The land capability classification is IIIs. The Michigan soil management group is 4a. The primary habitat type is TMC, and the secondary habitat type is TMV.

35B—Nadeau fine sandy loam, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats, knolls, and ridges in the uplands and on stream terraces.

Typically, the surface layer is black fine sandy loam about 4 inches thick. The subsurface layer is brown fine sandy loam about 9 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is brown, friable very gravelly loam. The lower part is brown, loose very gravelly loamy sand. The substratum to a depth of about 60 inches is brown very gravelly sand. In some areas the soil is moderately well drained. In other areas the subsoil is fine sandy loam or loam.

Included with this soil in mapping are scattered small areas of Mancelona, Emmet, and Pemene soils. These soils are in landscape positions similar to those of the Nadeau soil. Mancelona soils are coarser textured in the upper part of the subsoil than the Nadeau soil. Emmet and Pemene soils have fewer pebbles and cobbles in the subsoil and substratum than the Nadeau soil. Also included are small areas of the somewhat poorly drained Channing and Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Nadeau soil and very rapid in the lower part. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concern is the windthrow hazard. The equipment limitation is generally slight, but the use

of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced logging roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Because of the high content of pebbles and cobbles in the subsoil and substratum, trees tend to be shallow rooted. Some may be blown down during periods of strong winds and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

If this soil is cultivated, the major management concerns are droughtiness, soil blowing, and tilth. Small grain crops planted in the fall or early spring make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface increases the moisture supply by increasing the rate of water infiltration, helps to control soil blowing, and helps to prevent crusting during periods of heavy rainfall. If enough irrigation water is available, the soil can be irrigated. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 2S. The land capability classification is IIIs. The Michigan soil management group is 3/5a. The primary habitat type is TM, and the secondary habitat type is ATD.

35D—Nadeau fine sandy loam, 6 to 18 percent slopes. This gently rolling and rolling, well drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is black fine sandy loam about 4 inches thick. The subsurface layer is brown fine sandy loam about 9 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is brown, friable very gravelly loam. The lower part is brown, loose very gravelly loamy sand. The substratum to a depth of about 60 inches is brown very gravelly sand. In some areas the soil is moderately well drained. In other areas the subsoil is fine sandy loam or loam.

Included with this soil in mapping are scattered small areas of Mancelona, Emmet, and Pemene soils. These soils are in landscape positions similar to those of the Nadeau soil. Mancelona soils are coarser textured in the upper part of the subsoil than the Nadeau soil. Emmet and Pemene soils have fewer pebbles and cobbles in the subsoil and substratum than the Nadeau soil. Also included are small areas of the somewhat poorly drained Channing and Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Nadeau soil and very rapid in the lower part. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concern is the windthrow hazard. The equipment limitation is generally slight but is severe on sites for landings. Also, the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced logging roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Suitable landing sites may be available in the small included or adjacent areas of undulating soils. Because of the high content of pebbles and cobbles in the subsoil and substratum, trees tend to be shallow rooted. Some may be blown down during periods of strong winds and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

If this soil is cultivated, the major management concerns are droughtiness, water erosion, soil blowing, and tilth. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface increases the moisture supply and helps to control water erosion by increasing the rate of water infiltration, helps to control soil blowing, and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 2S. The land capability classification is IVe. The Michigan soil management group is 3/5a. The primary habitat type is TM, and the secondary habitat type is ATD.

35F—Nadeau fine sandy loam, 18 to 35 percent slopes. This hilly, well drained soil is on hills and ridges in the uplands.

Typically, the surface layer is black fine sandy loam about 4 inches thick. The subsurface layer is brown fine sandy loam about 9 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is brown, friable very gravelly loam. The lower part is brown, loose very gravelly loamy sand. The substratum to a depth of about 60 inches is

brown very gravelly sand. In places the subsoil is fine sandy loam or loam.

Included with this soil in mapping are scattered small areas of Mancelona, Emmet, and Pemene soils. These soils are in landscape positions similar to those of the Nadeau soil. Mancelona soils are coarser textured in the upper part of the subsoil than the Nadeau soil. Emmet and Pemene soils have fewer pebbles and cobbles in the subsoil and substratum than the Nadeau soil. Also included are small areas of the somewhat poorly drained Channing and Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Nadeau soil and very rapid in the lower part. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and the windthrow hazard. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible. In a few areas, rock outcrops hinder road construction. The use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover. Because of the high content of pebbles and cobbles in the subsoil and substratum, trees tend to be shallow rooted. Some may be blown down during periods of strong winds and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

This soil is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol is 2R. The land capability classification is VIIe. The Michigan soil management group is 3/5a. The primary habitat type is TM, and the secondary habitat type is ATD.

36B—Rousseau fine sand, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is light brownish gray fine sand about 6 inches thick. The subsoil is fine sand about 25 inches thick. The upper part is dark brown and very friable, and the lower part is brown and loose. The substratum to a depth of about 60 inches is light brown fine sand. In some places the soil is dominantly sand. In some places the substratum is gravelly sand or has bands of loamy fine sand. In some areas the soil is moderately well drained.

Included with this soil in mapping are scattered small areas of Pemene soils. These soils are finer textured than the Rousseau soil. They are in landscape positions similar to those of the Rousseau soil. Also included are small areas of the somewhat poorly drained Wainola and poorly drained Deford soils in depressions. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Rousseau soil. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are droughtiness, the organic matter content, and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface increases the moisture supply by increasing the rate of water infiltration. If enough irrigation water is available, the soil can be irrigated. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 5S. The land capability classification is IIIs. The Michigan soil management group is 4a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

36D—Rousseau fine sand, 6 to 18 percent slopes. This gently rolling and rolling, well drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is light brownish gray fine sand about 6 inches thick. The subsoil is fine sand about 25 inches thick. The upper part is dark brown and very friable, and the lower part is brown and loose. The substratum to a depth of about 60 inches is light brown fine sand. In some places the soil is dominantly sand. In

other places the substratum is gravelly sand or has bands of loamy fine sand.

Included with this soil in mapping are scattered small areas of Pemene soils. These soils are finer textured than the Rousseau soil. They are in landscape positions similar to those of the Rousseau soil. Also included are small areas of the somewhat poorly drained Wainola and poorly drained Deford soils in depressions and drainageways. Included soils make up about 10 to 12 percent of the unit.

Permeability is rapid in the Rousseau soil. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, droughtiness, and the organic matter content. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management, a cropping sequence that includes close-growing crops, and a system of conservation tillage that leaves crop residue on the surface help to control water erosion and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 5S. The land capability classification is IVe. The Michigan soil management group is 4a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

36F—Rousseau fine sand, 18 to 35 percent slopes. This hilly, well drained soil is on hills and ridges in the uplands.

Typically, the surface layer is light brownish gray fine sand about 6 inches thick. The subsoil is fine sand about 25 inches thick. The upper part is dark brown and very friable, and the lower part is brown and loose. The substratum to a depth of about 60 inches is light brown fine sand. In some places the soil is dominantly sand. In other places the substratum is gravelly sand or has bands of loamy fine sand.

Included with this soil in mapping are scattered small areas of Pemene soils. These soils are finer textured than the Rousseau soil. They are in landscape positions similar to those of the Rousseau soil. Also included are small areas of the somewhat poorly drained Wainola and poorly drained Deford soils in depressions and drainageways. Included soils make up about 8 to 10 percent of the unit.

Permeability is rapid in the Rousseau soil. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol is 5R. The land capability classification is VIIe. The Michigan soil management group is 4a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

46B—Oconto fine sandy loam, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats, knolls, and ridges in the uplands and on stream terraces.

Typically, the surface layer is dark brown fine sandy loam about 3 inches thick. The subsoil is about 35 inches thick. The upper part is dark brown, friable very fine sandy loam and strong brown, friable fine sandy loam. The next part is reddish brown loam and brown sandy loam. The lower part is dark brown loamy sand. The substratum to a depth of about 60 inches is light yellowish brown gravelly sand. In some places it is

slightly acid. In other places it is sand. In some areas the soil is moderately well drained.

Included with this soil in mapping are scattered small areas of Emmet, Pemene, and Pence soils. These soils are in landscape positions similar to those of the Oconto soil. Emmet and Pemene soils are finer textured in the substratum than the Oconto soil. Pence soils are shallower to gravelly sand than the Oconto soil. Also included are small areas of the somewhat poorly drained Channing and Solona soils in depressions and drainageways and a few areas that have rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Oconto soil and rapid or very rapid in the lower part. The available water capacity is moderate. Surface runoff is slow.

Most areas of this soil are used as woodland. The equipment limitation is generally slight, but the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3A. The land capability classification is IIe. The Michigan soil management group is 3/5a. The primary habitat type is TM, and the secondary habitat type is AVO.

46D—Oconto fine sandy loam, 6 to 18 percent slopes. This gently rolling and rolling, well drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is dark brown, friable fine sandy loam about 3 inches thick. The subsoil is about 35 inches thick. The upper part is dark brown, friable very fine sandy loam and strong brown, friable fine sandy loam. The next part is reddish brown loam and brown sandy loam. The lower part is dark brown loamy sand. The substratum to a depth of about 60 inches is light yellowish brown gravelly sand. In some places it is slightly acid. In other places it is sand.

Included with this soil in mapping are scattered small areas of Emmet, Pemene, and Pence soils. These soils are in landscape positions similar to those of the Oconto soil. Emmet and Pence soils are finer textured in the substratum than the Oconto soil. Pence soils are shallower to gravelly sand than the Oconto soil. Also included are small areas of the somewhat poorly drained Channing and Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways and a few areas that have rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Oconto soil and rapid or very rapid in the lower part. The available water capacity is moderate. Surface runoff is medium.

Most areas of this soil are used as woodland. The equipment limitation is generally slight but is severe on sites for landings. Also, the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. A permanent cover of grasses, crop residue management, and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and helps to prevent crusting during periods of heavy rainfall. Minimum tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3A. The land capability classification is IVe. The Michigan soil management group 3/5a. The primary habitat type is TM, and the secondary habitat type is AVO.

47A—Walnola fine sand, 0 to 3 percent slopes. This nearly level, somewhat poorly drained soil is on low flats and in depressions and drainageways.

Typically, the surface layer is black fine sand about 2 inches thick. The subsurface layer is grayish brown, very friable fine sand about 2 inches thick. The subsoil is

about 33 inches thick. The upper part is dark brown and brown, mottled, very friable loamy fine sand. The lower part is strong brown, loose fine sand. The substratum to a depth of about 60 inches is reddish yellow fine sand. In some places the upper part of the soil is dominantly fine sandy loam. In other places the soil is dominantly sand. In some areas the substratum has thin layers of fine sandy loam or gravelly sand.

Included with this soil in mapping are small areas of the well drained and moderately well drained Rousseau, well drained Pemene, and excessively drained Zimmerman soils on isolated knolls and ridges. Also included are small areas of the poorly drained Deford and very poorly drained Cathro soils on the lower parts of the landscape. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Wainola soil. The available water capacity is low. Surface runoff is slow. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet from fall to spring.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and the windthrow hazard. The seasonal high water table limits the use of equipment in the winter and spring. The equipment should be used only when the soil is dry or frozen or has an adequate snow cover. The well drained included soils are the best sites for landings during wet periods. Because of the wetness, the trees on this soil are shallow rooted. Some may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

If this soil is cultivated, the major management concerns are the seasonal wetness, the low available water capacity, the organic matter content, and soil blowing. Ponded water can be removed by surface drains, and the water table can be lowered by a subsurface drainage system. In some areas, however, adequate drainage outlets are not available. The soil may become quite droughty during extended dry periods. It can be irrigated if enough irrigation water is available. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface increases the moisture supply by increasing the rate of water infiltration. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 6W. The land capability classification is IIIw. The Michigan soil management group is 4b. The primary habitat type is TMC, and the secondary habitat type is TMC-V.

49B—Mancelona loamy sand, 0 to 6 percent slopes. This nearly level and undulating, somewhat excessively drained soil is on flats, knolls, and ridges in the uplands and on stream terraces.

Typically, the surface layer is black loamy sand about 1 inch thick. The subsurface layer is brown loamy sand about 2 inches thick. The subsoil is about 28 inches thick. The upper part is strong brown, very friable loamy sand and loose sand. The lower part is dark brown, friable gravelly loamy sand. The substratum to a depth of about 60 inches is strong brown very gravelly coarse sand. In places the upper part of the soil is fine sandy loam or loamy fine sand. In some areas the substratum is sand. In other areas it is medium acid. In some places the soil is moderately well drained. In other places it is stony or cobbly.

Included with this soil in mapping are scattered small areas of Oconto, Pemene, and Rubicon soils. These soils are in landscape positions similar to those of the Mancelona soil. Oconto and Pemene soils are finer textured than the Mancelona soil, and Rubicon soils are coarser textured. Also included are small areas of the somewhat poorly drained Channing, Solona, and Wainola soils in depressions and drainageways and a few areas that have rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Mancelona soil and very rapid in the lower part. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concern is seedling mortality. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are droughtiness, the organic matter content, and soil blowing. Small grain crops planted in fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface increases the moisture supply by increasing the rate of water infiltration. If enough irrigation water is available, the soil can be irrigated. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3S. The land capability classification is IIIs. The Michigan soil management group is 4a. The primary habitat type is AQVac, and the secondary habitat type is TM.

49D—Mancelona loamy sand, 6 to 18 percent slopes. This gently rolling and rolling, somewhat excessively drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is black loamy sand about 1 inch thick. The subsurface layer is brown loamy sand about 2 inches thick. The subsoil is about 28 inches thick. The upper part is strong brown, very friable loamy sand and loose sand. The lower part is dark brown, friable gravelly loamy sand. The substratum to a depth of about 60 inches is strong brown very gravelly coarse sand. In places the upper part of the profile is fine sandy loam or loamy fine sand. In some areas the substratum is sand. In other areas it is medium acid. In places the soil is stony or cobbly.

Included with this soil in mapping are small areas of Oconto, Pemene, and Rubicon soils. These soils are in landscape positions similar to those of the Mancelona soil. Oconto and Pemene soils are finer textured than the Mancelona soil, and Rubicon soils are coarser textured. Also included are small areas of the somewhat poorly drained Channing, Solona, and Wainola and poorly drained Deford and Ensley soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Mancelona soil and very rapid in the lower part. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are seedling mortality and the equipment limitation on landings. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, droughtiness, and the organic matter content. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. A permanent cover of grasses, crop residue management, and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and conserves moisture. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3S. The land capability classification is IVe. The Michigan soil management group is 4a. The primary habitat type is AQVac, and the secondary habitat type is TM.

49F—Mancelona loamy sand, 18 to 35 percent slopes. This hilly, somewhat excessively drained soil is on hills and ridges in the uplands.

Typically, the surface layer is black loamy sand about 1 inch thick. The subsurface layer is brown, loose loamy sand about 2 inches thick. The subsoil is about 29 inches thick. The upper part is strong brown, very friable loamy sand and loose sand. The lower part is dark brown, friable gravelly loamy sand. The substratum to a depth of about 60 inches is strong brown very gravelly coarse sand. In places the upper part of the soil is fine sandy loam or loamy fine sand. In some areas the substratum is sand. In other areas it is medium acid. In places the soil is stony or cobbly.

Included with this soil in mapping are scattered small areas of Oconto, Pemene, and Rubicon soils. These soils are in landscape positions similar to those of the Mancelona soil. Oconto and Pemene soils are finer textured than the Mancelona soil, and Rubicon soils are coarser textured. Also included are small areas of the somewhat poorly drained Channing and Solona, poorly drained Ensley and Deford, and very poorly drained Cathro soils in depressions and drainageways and a few areas that have rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Mancelona soil and very rapid in the lower part. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and seedling mortality. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible. In a few areas rock outcrops hinder road construction.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling

survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol is 3R. The land capability classification is VIIe. The Michigan soil management group is 4a. The primary habitat type is AQVac, and the secondary habitat type is TM.

50—Pits. This map unit consists of open excavations from which the soil material has been removed. Unconsolidated material has been removed for use elsewhere as fill or aggregate. The pits support few plants. The pit bottoms may be dry or seasonally ponded. In some small areas they are permanently covered with water.

Most areas are idle. An individual assessment of each area is necessary to determine the potential for different uses.

No interpretive groups are assigned.

55—Kinross mucky fine sand. This nearly level, poorly drained soil is on low flats and in depressions and drainageways. It is subject to ponding.

Typically, the surface layer is black mucky fine sand about 3 inches thick. The subsurface layer is brown, mottled loamy fine sand about 6 inches thick. The subsoil is mottled fine sand about 27 inches thick. The upper part is dark reddish brown and very friable, and the lower part is strong brown and loose. The substratum to a depth of about 60 inches is brown fine sand. In places it has thin layers of very fine sandy loam.

Included with this soil in mapping are small areas of the moderately well drained Rousseau soils on isolated knolls and ridges and small areas of the somewhat poorly drained Wainola soils in the slightly higher landscape positions. Also included are small areas of the very poorly drained Cathro and Dawson soils in the slightly lower positions. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Kinross soil. The available water capacity is low. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from fall to spring.

This soil is used as woodland. The major management concerns are the equipment limitation, seedling mortality, and the windthrow hazard. The seasonal high water table restricts the use of equipment in late fall and in winter and spring. The equipment should be used only when the soil is dry or frozen or has an adequate snow cover. Because of the wetness, loss of seedlings can be more than 50 percent and the trees are shallow rooted. Many trees may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Trees generally are not planted on this soil because of wetness and low productivity.

The woodland ordination symbol is 2W. The land capability classification is VIw. The Michigan soil management group is 5c-a. The primary habitat type is PCS.

57B—Vilas loamy sand, 0 to 6 percent slopes. This nearly level and undulating, excessively drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is black loamy sand about 3 inches thick. The subsoil is about 31 inches thick. The upper part is dark brown and strong brown, very friable and loose loamy sand. The lower part is strong brown, loose sand. The substratum to a depth of about 60 inches is brown and light brown sand. In places the upper part of the soil is loamy fine sand or fine sandy loam. In some areas the substratum is gravelly sand. In other areas it has bands of loamy fine sand.

Included with this soil in mapping are scattered small areas of Pemene soils. These soils are finer textured than the Vilas soil. They are in landscape positions similar to those of the Vilas soil. Also included are small areas of moderately well drained, sandy soils and the somewhat poorly drained Wainola and Channing soils in depressions and drainageways. Included soils make up about 10 to 12 percent of the unit.

Permeability is rapid in the upper part of the Vilas soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland (fig. 6). The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are droughtiness, the organic matter content, and soil blowing. Small grain crops planted in fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface increases the moisture supply by increasing the rate of water infiltration. If enough irrigation water is available, the soil can be irrigated. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 6S. The land capability classification is IVs. The Michigan soil

Figure 6.—A typical open stand of aspen on Vilas loamy sand, 0 to 6 percent slopes.

management group is 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

57D—Vilas loamy sand, 6 to 18 percent slopes. This gently rolling and rolling, excessively drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is black loamy sand about 3 inches thick. The subsoil is about 31 inches thick. The upper part is dark brown and strong brown, very friable and loose loamy sand. The lower part is strong brown, loose sand. The substratum to a depth of about 60 inches is brown and light brown sand. In places the upper part of the soil is loamy fine sand or fine sandy loam. In some areas the substratum is gravelly sand. In other areas it has bands of loamy fine sand.

Included with this soil in mapping are scattered small areas of Pemene soils. These soils are finer textured than the Vilas soil. They are in landscape positions similar to those of the Vilas soil. Also included are small areas of moderately well drained, sandy soils and the somewhat poorly drained Wainola and Channing soils in depressions and drainageways. Included soils make up about 10 to 15 percent of the unit.

Permeability is rapid in the upper part of the Vilas soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Suitable landing sites may be available in the small included or adjacent areas of nearly level and undulating soils. Because of droughtiness, loss of seedlings can be as high as 25 to 50 percent. Special planting stock or

containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

The woodland ordination symbol is 6S. The land capability classification is VIIs. The Michigan soil management group is 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

57F—Vilas loamy sand, 18 to 35 percent slopes. This hilly, excessively drained soil is on hills and ridges in the uplands.

Typically, the surface layer is black loamy sand about 3 inches thick. The subsoil is about 31 inches thick. The upper part is dark brown and strong brown, very friable and loose loamy sand. The lower part is strong brown, loose sand. The substratum to a depth of about 60 inches is brown and light brown sand. In places the upper part of the soil is loamy fine sand or fine sandy loam. In some areas the substratum is gravelly sand. In other areas it has bands of loamy fine sand.

Included with this soil in mapping are scattered small areas of Pemene soils. These soils are finer textured than the Vilas soil. They are in landscape positions similar to those of the Vilas soil. Also included are small areas of the somewhat poorly drained Wainola and Channing and poorly drained Deford and Ensley soils in depressions and drainageways. Included soils make up about 10 to 15 percent of the unit.

Permeability is rapid in the upper part of the Vilas soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil is not suitable as cropland because of the slope, the droughtiness, and the hazard of water erosion.

The woodland ordination symbol is 6R. The land capability classification is VIIs. The Michigan soil management group is 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

59A—Channing fine sandy loam, 0 to 3 percent slopes. This nearly level, somewhat poorly drained soil is on low flats and in depressions and drainageways.

Typically, the surface layer is dark reddish brown fine sandy loam about 5 inches thick. The subsoil is about 18 inches thick. The upper part is dark reddish brown, mottled, friable fine sandy loam. The lower part is reddish brown, mottled, very friable, stratified fine sandy loam and loamy fine sand. The substratum to a depth of about 60 inches is light brown, stratified sand and gravelly sand. In some places it is sand. In other places the soil is cobbly or stony.

Included with this soil in mapping are scattered small areas of Pence and Wainola soils. The well drained Pence soils are on knolls and ridges. Wainola soils are in landscape positions similar to those of the Channing soil. They are coarser textured than the Channing soil. Also included are small areas of the poorly drained Deford and Ensley soils in the slightly lower landscape positions. Included soils make up about 8 to 12 percent of the unit.

Permeability is moderate in the upper part of the Channing soil and very rapid in the lower part. The available water capacity is low. Surface runoff is slow. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet from fall to spring.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and the windthrow hazard. The seasonal high water table restricts the use of equipment in winter and spring. The equipment should be used only when the soil is dry or frozen or has an adequate snow cover. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. A gravel base is needed if logging roads are used throughout the year. Because of the wetness and the gravelly substratum, the trees on this soil are shallow rooted. Some may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

If this soil is cultivated, the major management concerns are the seasonal wetness and the hazard of soil blowing. Excess surface water can be removed by surface drains, and the high water table can be lowered by subsurface drains. In some areas, however, adequate drainage outlets are not available. A system of conservation tillage that leaves crop residue on the surface helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction.

Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, and permeability. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 2W. The land capability classification is IIIw. The Michigan soil management group is 3/5b. The primary habitat type is TMC.

60B—Zimmerman fine sand, 0 to 6 percent slopes. This nearly level and undulating, excessively drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is black fine sand about 3 inches thick. The subsoil is about 57 inches thick. The upper part is brown, very friable fine sand. The next layer is reddish yellow and yellowish brown fine sand. The lower part is reddish yellow fine sand that has thin bands of dark brown loamy fine sand. In some places the soil is dominantly sand. In other places it does not have bands of finer textured material in the lower part of the subsoil. In some areas the lower part of the soil is gravelly sand. In other areas the soil is moderately well drained. In places it is cobbly or stony.

Included with this soil in mapping are scattered small areas of Escanaba and Pemene soils. These soils are finer textured than the Zimmerman soil. They are in landscape positions similar to those of the Zimmerman soil. Also included are small areas of the somewhat poorly drained Wainola and Solona soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is rapid in the Zimmerman soil. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland (fig. 7). The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Because of droughtiness, loss of seedlings can be more than 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are droughtiness, the organic matter content, and soil blowing. Small grain crops planted in the early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface increases the moisture supply by increasing the rate of water infiltration. If enough irrigation water is available, the soil can be irrigated. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Conservation tillage, field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 8S. The land capability classification is IIIs. The Michigan soil management group is 4a. The primary habitat type is TMV, and the secondary habitat type is AQVac.

60D—Zimmerman fine sand, 6 to 18 percent slopes. This gently rolling and rolling, excessively drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is black fine sand about 3 inches thick. The subsoil is about 57 inches thick. The upper part is brown, very friable fine sand. The next part is reddish yellow and yellowish brown fine sand. The lower part is reddish yellow fine sand that has thin bands of dark brown loamy fine sand. In some places the soil is dominantly sand. In other places it does not have bands of finer textured material in the lower part of the subsoil. In some areas the lower part of the soil is gravelly sand. In other areas the soil is cobbly or stony.

Included with this soil in mapping are scattered small areas of Escanaba and Pemene soils. These soils are finer textured than the Zimmerman soil. They are in landscape positions similar to those of the Zimmerman soil. Also included are small areas of the somewhat poorly drained Wainola and Solona and poorly drained Deford and Ensley soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is rapid in the Zimmerman soil. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils. Because of droughtiness, loss of seedlings can be more than 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, the low available water capacity, and the organic matter content. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management, a cropping sequence that includes close-growing crops, and a system of conservation tillage that leaves crop

Figure 7.—A stand of aspen on Zimmerman fine sand, 0 to 6 percent slopes. Brackenfern is a common ground species.

residue on the surface help to control water erosion and soil blowing and maintain the organic matter content. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence increase the organic matter content, the level of fertility, and the rate of water infiltration. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 8S. The land capability classification is IVe. The Michigan soil management group is 4a. The primary habitat type is TMV, and the secondary habitat type is AQVac.

60F—Zimmerman fine sand, 18 to 35 percent slopes. This hilly, excessively drained soil is on hills and ridges in the uplands.

Typically, the surface layer is black fine sand about 3 inches thick. The subsoil is about 57 inches thick. The upper part is brown, very friable fine sand. The next part is reddish yellow and yellowish brown fine sand. The lower part is reddish yellow fine sand that has thin bands of dark brown loamy fine sand. In some places the soil is dominantly sand. In other places it does not have bands of finer textured material in the lower part of the subsoil. In some areas the lower part of the soil is gravelly sand. In other areas the soil is cobbly or stony.

Included with this soil in mapping are small areas of Pemene soils. These soils are finer textured than the Zimmerman soil. They are in landscape positions similar to those of the Zimmerman soil. Also included are small areas of the somewhat poorly drained Wainola and Solona soils in depressions and drainageways and some

areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is rapid in the Zimmerman soil. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible. Rock outcrops can hinder road construction in a few areas.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

Because of droughtiness, loss of tree seedlings can be more than 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol is 8R. The land capability classification is VIIe. The Michigan soil management group is 4a. The primary habitat type is TMV, and the secondary habitat type is AQVac.

64B—Rubicon sand, 0 to 6 percent slopes. This nearly level and undulating, excessively drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is dark reddish brown sand about 2 inches thick. The subsurface layer is pinkish gray sand about 3 inches thick. The subsoil is sand about 36 inches thick. The upper part is dark brown and very friable, and the lower part is strong brown and loose. The substratum to a depth of about 60 inches is strong brown sand. In some places the soil is dominantly fine sand. In other places the substratum is gravelly sand or has bands of loamy sand. In some areas the soil is moderately well drained. In other areas it is cobbly or stony.

Included with this soil in mapping are scattered small areas of Pemene soils. These soils are finer textured than the Rubicon soil. They are in landscape positions similar to those of the Rubicon soil. Also included are small areas of the somewhat poorly drained Wainola and poorly drained Deford and Kinross soils in depressions and drainageways. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Rubicon soil. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

The woodland ordination symbol is 4S. The land capability classification is VIs. The Michigan soil management group is 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

64D—Rubicon sand, 6 to 18 percent slopes. This gently rolling and rolling, excessively drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is dark reddish brown sand about 2 inches thick. The subsurface layer is pinkish gray sand about 3 inches thick. The subsoil is sand about 36 inches thick. The upper part is dark brown and very friable, and the lower part is strong brown and loose. The substratum to a depth of about 60 inches is strong brown sand. In some places the soil is dominantly fine sand. In other places the substratum is gravelly sand or has bands of loamy sand. In some areas the soil is cobbly or stony.

Included with this soil in mapping are scattered small areas of Pemene soils. These soils are finer textured than the Rubicon soil. They are in landscape positions similar to those of the Rubicon soil. Also included are small areas of the somewhat poorly drained Wainola and poorly drained Deford and Kinross soils in depressions and drainageways. Included soils make up about 5 to 15 percent of the unit.

Permeability is rapid in the Rubicon soil. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils. Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil generally is not suitable as cropland because of the droughtiness and the slope.

The woodland ordination symbol is 4S. The land capability classification is VIIs. The Michigan soil management group is 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

64F—Rubicon sand, 18 to 35 percent slopes. This hilly, excessively drained soil is on hills and ridges in the uplands.

Typically, the surface layer is dark reddish brown sand about 2 inches thick. The subsurface layer is pinkish gray sand about 3 inches thick. The subsoil is sand about 36 inches thick. The upper part is dark brown and very friable, and the lower part is strong brown and loose. The substratum to a depth of about 60 inches is strong brown sand. In some places the soil is dominantly fine sand. In other places the substratum is gravelly sand or has bands of loamy sand. In some areas the soil is cobbly or stony.

Included with this soil in mapping are scattered small areas of Pemene soils. These soils are finer textured than the Rubicon soil. They are in landscape positions similar to those of the Rubicon soil. Also included are small areas of the somewhat poorly drained Wainola and poorly drained Deford and Kinross soils in depressions and drainageways. Included soils make up about 5 to 15 percent of the unit.

Permeability is rapid in the Rubicon soil. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

Because of droughtiness, loss of tree seedlings can be as high as 25 to 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This soil is not suitable as cropland because of the slope, the droughtiness, and the hazard of water erosion.

The woodland ordination symbol is 4R. The land capability classification is VIIs. The Michigan soil management group is 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

65—Pits and Dumps, mine. These are areas that have been mined for ore or rock (fig. 8). The pits are large and are enclosed by nearly vertical walls. The areas adjacent to the pits are covered by the waste products of the mining process. This unit supports few plants. Water is in many of the pits. Much of the dump material occurs as steep piles of rock fragments that vary in size.

Most areas are idle. An individual assessment of each area is necessary to determine the potential for different uses.

No interpretive groups are assigned.

66D—Zimmerman-Rock outcrop complex, 6 to 18 percent slopes. This map unit occurs as areas of a gently rolling and rolling, excessively drained Zimmerman soil intermingled with areas of Rock outcrop. The unit is on foot slopes, side slopes, and ridges in the uplands. Areas are about 60 to 70 percent Zimmerman soil and 10 to 15 percent Rock outcrop. The Zimmerman soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Zimmerman soil has a surface layer of black fine sand about 3 inches thick. The subsoil is about 57 inches thick. The upper part is brown, very friable fine sand. The next part is reddish yellow and yellowish brown fine sand. The lower part is reddish yellow fine sand that has thin bands of dark brown loamy fine sand. In some places the soil is dominantly sand. In other places it does not have bands of finer textured material in the lower part of the subsoil. In some areas the lower part of the soil is gravelly sand. In other areas the soil is stony or bouldery.

Included in this unit in mapping are scattered small areas of Pemene soils and soils that have bedrock within 60 inches of the surface. These soils are in landscape positions similar to those of the Zimmerman soil. Pemene soils are finer textured than the Zimmerman soil. Also included are small areas of the somewhat poorly drained Wainola and Solona, poorly drained Deford and Ensley, and very poorly drained Cathro soils in depressions and drainageways. Included soils make up about 20 to 25 percent of the unit.

Permeability is rapid in the Zimmerman soil. The available water capacity is low. Surface runoff is slow.

This unit is used as woodland. The major management concerns are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Bedrock in a few areas and rock outcrops can hinder road construction. Suitable landing sites may be available in the small included or

Figure 8.—An area of Pits and Dumps, mine.

adjacent areas of nearly level or undulating soils. Because of droughtiness, loss of tree seedlings can be more than 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

The woodland ordination symbol assigned to the Zimmerman soil is 8S. The land capability classification is VIIe. The Michigan soil management group is 4a. The primary habitat is TMV, and the secondary habitat type is AQVac.

66F—Zimmerman-Rock outcrop complex, 18 to 35 percent slopes. This map unit occurs as areas of a hilly, excessively drained Zimmerman soil intermingled with areas of Rock outcrop. The unit is on hills and ridges in the uplands. Areas are about 55 to 65 percent Zimmerman soil and 15 to 20 percent Rock outcrop. The Zimmerman soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Zimmerman soil has a surface layer of black fine sand about 3 inches thick. The subsoil is about 57 inches thick. The upper part is brown, very friable fine sand. The next part is reddish yellow and yellowish brown fine sand. The lower part is reddish yellow fine sand that has thin bands of dark brown loamy fine sand. In some places the soil is dominantly sand. In other places it does not have bands of finer textured material in the lower part of the subsoil. In some areas the lower part of the soil is gravelly sand. In other areas the soil is stony or bouldery.

Included with this soil in mapping are scattered small areas of Pemene soils and soils that have bedrock within

60 inches of the surface. These soils are in landscape positions similar to those of the Zimmerman soil. Pemene soils are finer textured than the Zimmerman soil. Also included are small areas of the somewhat poorly drained Wainola and Solona, poorly drained Deford and Ensley, and very poorly drained Cathro soils in depressions and drainageways. Included soils make up about 20 to 25 percent of the unit.

Permeability is rapid in the Zimmerman soil. The available water capacity is low. Surface runoff is medium.

This unit is used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Bedrock and rock outcrops hinder road construction. Rock outcrops can hinder harvesting activities. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

Because of droughtiness, loss of tree seedlings can be more than 50 percent. Special planting stock or containerized seedlings, overstocking, and special site preparation, such as furrowing, increase the seedling survival rate. Harvest methods that leave some mature trees to provide shade and protection may be desirable.

This unit is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol assigned to the Zimmerman soil is 8R. The land capability classification is VIIe. The Michigan soil management group is 4a. The primary habitat type is TMV, and the secondary habitat type is AQVac.

67—Udorthents, loamy. These nearly level and undulating, well drained to somewhat poorly drained soils are in areas where the original soil material has been removed and a loamy substratum is exposed. They also are in areas covered with loamy soil material brought in from other areas.

These soils do not have genetically developed soil layers. In some areas they have layers of varying texture because of geologic deposition or the deposition occurring when the landscape was altered by human activities. Most of the material is fine sandy loam, loamy fine sand, or loam. A few areas are sandy.

These soils are generally idle or are used as building sites. An individual assessment of each area is necessary to determine the potential for different uses.

No interpretive groups are assigned.

68D—Pemene-Rock outcrop complex, 6 to 18 percent slopes. This map unit occurs as areas of a gently rolling and rolling, well drained Pemene soil intermingled with areas of Rock outcrop. The unit is on foot slopes, side slopes, and ridges in the uplands. Areas are about 60 to 70 percent Pemene soil and 15 to 20 percent Rock outcrop. The Pemene soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Pemene soil has a surface layer of black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam. In some places, the upper part of the soil is loamy fine sand and the lower part is fine sandy loam. In other places the soil is dominantly fine sandy loam and loam. In some areas it is stony or bouldery.

Included in this unit in mapping are small areas of Zimmerman, Mancelona, and Karlin soils. These soils are coarser textured than the Pemene soil. They are mainly on foot slopes and in valleys. Also included are small areas of the somewhat poorly drained Solona and Wainola, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways. Included soils make up about 20 to 25 percent of the unit.

Permeability is moderate or moderately rapid in the Pemene soil. The available water capacity is moderate. Surface runoff is medium.

This unit is used as woodland. The Rock outcrop can hinder road construction and harvesting activities. As a result, special care is needed in designing and laying out logging roads. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

The woodland ordination symbol assigned to the Pemene soil is 4S. The land capability classification is VIe. The Michigan soil management group is 3a. The primary habitat type is TM, and the secondary habitat type is ATD.

68F—Pemene-Rock outcrop complex, 18 to 35 percent slopes. This map unit occurs as areas of a hilly, well drained Pemene soil intermingled with areas of Rock outcrop. The unit is on hills and ridges in the uplands. Areas are about 55 to 65 percent Pemene soil and 15 to 20 percent Rock outcrop. The Pemene soil and Rock outcrop occur as areas so intricately mixed or

so small that separating them in mapping was not practical.

Typically, the Pemene soil has a surface layer of black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam. In some places, the upper part of the soil is loamy fine sand and the lower part is fine sandy loam. In other places the soil is dominantly fine sandy loam and loam. In some areas it is stony or bouldery.

Included in this unit in mapping are small areas of Zimmerman, Mancelona, and Karlin soils. These soils are coarser textured than the Pemene soil. They are mainly on foot slopes and in valleys. Also included are small areas of the somewhat poorly drained Solona and Wainola, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways. Included soils make up about 20 to 25 percent of the unit.

Permeability is moderate or moderately rapid in the Pemene soil. The available water capacity is moderate. Surface runoff is medium.

This unit is used as woodland. The major management concerns are the equipment limitation and the erosion hazard. Rock outcrop can hinder road construction and harvesting activities. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

This unit is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol assigned to the Pemene soil is 4R. The land capability classification is VIIe. The Michigan soil management group is 3a. The primary habitat type is TM, and the secondary habitat type is ATD.

69D—Emmet-Rock outcrop complex, 6 to 18 percent slopes. This map unit occurs as areas of a gently rolling and rolling, well drained Emmet soil intermingled with areas of Rock outcrop. The unit is on foot slopes, side slopes, and ridges in the uplands. Areas are about 60 to 70 percent Emmet soil and 15 to 20 percent Rock outcrop. The Emmet soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Emmet soil has a surface layer of black loam about 2 inches thick. The subsurface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is reddish brown, friable sandy loam. The lower part is reddish brown, friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam. In places it is loamy fine sand. In some areas the soil is stony or bouldery.

Included in this unit in mapping are small areas of Escanaba, Nadeau, and Rousseau soils. Escanaba and Rousseau soils are coarser textured than the Emmet soil. They are generally on foot slopes and in valleys. Nadeau soils have more cobbles and stones in the substratum than the Emmet soil. They are mainly on narrow, steep-sided ridges. Also included are small areas of the somewhat poorly drained Solona and Wainola, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways. Included soils make up about 20 to 25 percent of the unit.

Permeability is moderate in the Emmet soil. The available water capacity also is moderate. Surface runoff is medium.

This unit is used as woodland. The equipment limitation is generally slight, but the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Rock outcrops can hinder road construction and harvesting activities. Careful planning of logging roads is needed because of the rock outcrops. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

The woodland ordination symbol assigned to the Emmet soil is 3A. The land capability classification is VIe. The Michigan soil management group is 3a. The primary habitat type is AVO, and the secondary habitat type is ATD.

69F—Emmet-Rock outcrop complex, 18 to 35 percent slopes. This map unit occurs as areas of a hilly, well drained Emmet soil intermingled with areas of Rock outcrop. The unit is on hills and ridges in the uplands. Areas are about 55 to 65 percent Emmet soil and 15 to 20 percent Rock outcrop. The Emmet soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Emmet soil has a surface layer of black loam about 2 inches thick. The subsurface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, friable fine sandy loam. The next part is reddish brown, friable sandy loam. The lower part is reddish brown,

friable fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam. In places it is loamy fine sand. In some areas the soil is stony or bouldery.

Included in this unit in mapping are small areas of Escanaba, Nadeau, and Rousseau soils. Escanaba and Rousseau soils are coarser textured than the Emmet soil. They are generally on foot slopes and in valleys. Nadeau soils have more cobbles and stones in the substratum than the Emmet soil. They are mainly on narrow, steep-sided ridges. Also included are small areas of the somewhat poorly drained Solona and Wainola, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways. Included soils make up about 20 to 25 percent of the unit.

Permeability is moderate in the Emmet soil. The available water capacity also is moderate. Surface runoff is medium.

This unit is used as woodland. The major management concerns are the equipment limitation and the erosion hazard. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. The roads should be designed so that they conform to the topography, and the grade should be kept as low as possible. The use of equipment may be briefly limited in the spring and other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Rock outcrops can hinder road construction and harvesting activities.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover.

This unit is not suitable as cropland because of the slope and the hazard of water erosion.

The woodland ordination symbol assigned to the Emmet soil is 3R. The land capability classification is VIIe. The Michigan soil management group is 3a. The primary habitat type is AVO, and the secondary habitat type is ATD.

70B—Solona fine sandy loam, 0 to 4 percent slopes. This nearly level and undulating, somewhat poorly drained soil is on low flats and in depressions and drainageways.

Typically, the surface layer is black fine sandy loam about 5 inches thick. The subsoil is fine sandy loam about 18 inches thick. The upper part is dark brown and very friable, and the lower part is dark brown and brown, mottled, and friable. The substratum to a depth of about 60 inches is brown and reddish brown fine sandy loam and very fine sandy loam. In some places it is fine sand. In other places the upper part of the soil is loamy fine sand.

Included with this soil in mapping are small areas of the well drained Pemene, Emmet, and Rousseau soils on knolls and ridges and scattered small areas of Wainola soils. Wainola soils are coarser textured than the Solona soil. They are in landscape positions similar to those of the Solona soil. Also included are areas of the poorly drained Deford and Ensley and very poorly drained Cathro soils in the lower landscape positions. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Solona soil. The available water capacity also is moderate. Surface runoff is slow. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet from fall to spring.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and the windthrow hazard. The seasonal high water table limits the use of equipment in winter and spring. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts can restrict lateral drainage and result in damage to tree roots. Equipment should be used only when the soil is dry or frozen or has an adequate snow cover. The included areas of well drained soils are the best sites for landings. Year-round logging roads should be graveled. Because of the seasonal high water table, the trees on this soil are shallow rooted. Some may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

If this soil is cultivated, the major management concerns are wetness, water erosion, soil blowing, and tilth. Excess surface water can be removed by surface drains, and the high water table can be lowered by subsurface drains. In some areas, however, adequate drainage outlets are not available. An adequate drainage system helps to maintain good tilth. A system of conservation tillage that leaves crop residue on the surface helps to prevent crusting during periods of heavy rainfall and helps to control water erosion by increasing the rate of water infiltration. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3W. The land capability classification is IIw. The Michigan soil

management group is 3b. The primary habitat type is TMC, and the secondary habitat type is AVO.

71—Ensley fine sandy loam. This nearly level, poorly drained soil is on low flats and in depressions and drainageways. It is subject to ponding.

Typically, the surface layer is black fine sandy loam about 3 inches thick. The subsurface layer is dark grayish brown, mottled fine sandy loam about 6 inches thick. The subsoil is dark yellowish brown, mottled, friable fine sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is yellowish brown, brown, and strong brown fine sandy loam. In some places it is fine sand. In other places the upper part of the soil is loamy fine sand. In some areas the soil is cobbly or stony.

Included with this soil in mapping are small areas of the well drained Pemene, Emmet, and Rousseau and somewhat poorly drained Solona and Wainola soils on knolls and ridges. Also included are scattered small areas of Hettinger soils and the very poorly drained Cathro soils. These soils are in landscape positions similar to those of the Ensley soil. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Ensley soil and moderately rapid in the lower part. The available water capacity is moderate. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from fall to spring.

This soil is used as woodland. The major management concerns are the equipment limitation, seedling mortality, and the windthrow hazard. The seasonal high water table limits the use of equipment in late fall, in winter, and in spring. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts can restrict lateral drainage and result in damage to tree roots. Equipment should be used only when the soil is dry or frozen or has an adequate snow cover. Trees are not generally planted on this soil because of the wetness, seedling mortality, and low productivity. Because of the wetness, loss of seedlings can be more than 50 percent and the trees are shallow rooted. Many trees may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

The woodland ordination symbol is 3W. The land capability classification is Vw. The Michigan soil management group is 3c. The primary habitat type is TTM, and the secondary habitat type is TTS.

72—Aquents and Histosols, ponded. These nearly level, very poorly drained soils are in marshes. They are ponded during all periods, except for prolonged dry periods. The Aquents are sandy or loamy, and the Histosols are organic. Some areas are made up entirely of either Histosols or Aquents, and others are made up of both soils.

Most areas support marsh vegetation, mainly cattails, sedges, and rushes. These soils are difficult to manage for most uses because of the ponding. They provide habitat for waterfowl, beavers, muskrats, and other wetland species. They are generally unsuited to other uses.

No interpretive groups are assigned.

75B—Alstad loam, 0 to 6 percent slopes. This nearly level and undulating, somewhat poorly drained soil is on low flats, knolls, and ridges in the uplands.

Typically, the surface layer is dark reddish brown loam about 4 inches thick. The subsoil is about 38 inches thick. It is mottled. In sequence downward, it is dark brown, friable loam; grayish brown, firm fine sandy loam; dark reddish brown, firm clay loam and grayish brown, friable fine sandy loam; and dark reddish brown, friable clay loam. The substratum to a depth of about 60 inches is reddish brown clay loam. In some areas the soil is moderately well drained. In other areas the substratum is fine sand or loamy fine sand.

Included with this soil in mapping are small areas of the well drained Emmet soils on the higher parts of knolls and ridges and scattered small areas of Solona and Wainola soils. Solona and Wainola soils are coarser textured than the Alstad soil. They are in landscape positions similar to those of the Alstad soil. Also included are small areas of the poorly drained Hettinger and Deford soils in the slightly lower landscape positions. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Alstad soil and moderately slow in the lower part. The available water capacity is high. Surface runoff is slow. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet from fall to spring.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and the windthrow hazard. The seasonal high water table limits the use of equipment in winter and spring. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts can restrict lateral drainage and result in damage to tree roots. Equipment should be used only when the soil is dry or frozen or has an adequate snow cover. The small included areas of well drained soils are the best landing sites. Year-round logging roads should be graveled. Because of the seasonal high water table, the trees on this soil are shallow rooted. Some may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

If this soil is cultivated, the major management concerns are wetness, water erosion, and tilth. Ponded water can be removed by surface drains, and the water table can be lowered by subsurface drains. In some areas, however, adequate drainage outlets are not available. An adequate drainage system helps to maintain good tilth. A system of conservation tillage that

leaves crop residue on the surface helps to prevent crusting during periods of heavy rainfall and helps to control water erosion by increasing the rate of water infiltration. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion.

The woodland ordination symbol is 3W. The land capability classification is IIw. The Michigan soil management group is 2.5b. The primary habitat type is TMC.

76B—Emmet-Pemene fine sandy loams, 0 to 6 percent slopes. These are nearly level and undulating, well drained soils on flats, knolls, and ridges in the uplands. Areas are about 45 to 60 percent Emmet soil and 30 to 40 percent Pemene soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Emmet soil has a surface layer of black loam about 2 inches thick. The subsurface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. It is friable. The upper part is dark brown fine sandy loam. The next part is reddish brown sandy loam. The lower part is reddish brown fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam. In some areas the soil is moderately well drained. In other areas the surface layer is cobbly or stony.

Typically, the Pemene soil has a surface layer of black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam. In some areas the soil is moderately well drained. In other areas, the upper part of the soil is loamy fine sand and the lower part is fine sandy loam. In places the surface layer is cobbly or stony.

Included with these soils in mapping are small areas of Rousseau, Zimmerman, Mancelona, and Karlin soils. These included soils are coarser textured than the Emmet and Pemene soils. They are mainly on foot slopes and in valleys. Also included are small areas of Nadeau soils, generally on narrow, steep-sided ridges; small areas of the somewhat poorly drained Solona and Wainola, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways; and some areas that have a few rock outcrops. Nadeau soils have more cobbles and stones in the substratum than the Emmet and Pemene soils. Included areas make up about 20 to 25 percent of the unit.

Permeability is moderate in the Emmet soil and moderate or moderately rapid in the Pemene soil. The available water capacity is moderate in both soils. Surface runoff is slow.

Most areas of these soils are used as woodland. The equipment limitation is generally slight, but the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use.

If these soils are cultivated, the major management concerns are water erosion, soil blowing, droughtiness, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and maintain the content of organic matter. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing, increases the moisture supply by increasing the rate of water infiltration, and helps to prevent crusting during periods of heavy rainfall. If enough irrigation water is available, the soil can be irrigated. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol assigned to the Emmet soil is 3A, and that assigned to the Pemene soil is 4S. The land capability classification is IIe. The Michigan soil management group is 3a. The primary habitat type is TM, and the secondary habitat type is ATD.

76D—Emmet-Pemene fine sandy loams, 6 to 18 percent slopes. These are gently rolling and rolling, well drained soils on foot slopes, side slopes, and ridges in the uplands. Areas are about 40 to 50 percent Emmet soil and 30 to 40 percent Pemene soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Emmet soil has a surface layer of black loam about 2 inches thick. The subsurface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is about 29 inches thick. It is friable. The upper part is dark brown fine sandy loam. The next part is reddish

brown sandy loam. The lower part is reddish brown fine sandy loam. The substratum to a depth of about 60 inches is reddish brown gravelly fine sandy loam. In places the surface layer is cobbly or stony.

Typically, the Pemene soil has a surface layer of black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam. In some places, the upper part of the soil is loamy fine sand and the lower part is fine sandy loam. In other places the surface layer is cobbly or stony.

Included with these soils in mapping are small areas of Rousseau, Zimmerman, Mancelona, and Karlin soils. These included soils are coarser textured than the Emmet and Pemene soils. They are mainly on foot slopes and in valleys. Also included are small areas of Nadeau soils, generally on narrow, steep-sided ridges; small areas of the somewhat poorly drained Solona and Wainola, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways; and some areas that have a few rock outcrops. Nadeau soils have more cobbles and stones in the substratum than the Emmet and Pemene soils. Included areas make up about 20 to 25 percent of the unit.

Permeability is moderate in the Emmet soil and moderate or moderately rapid in the Pemene soil. The available water capacity is moderate in both soils. Surface runoff is medium.

Most areas of these soils are used as woodland. The equipment limitation is generally slight but is severe on sites for landings. Also, the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

If these soils are cultivated, the major management concerns are water erosion, soil blowing, droughtiness, and tilth. Contour tillage and contour stripcropping slow runoff. A permanent cover of grasses is effective in controlling water erosion. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing, conserves moisture, and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol assigned to the Emmet soil is 3A, and that assigned to the Pemene soil is 4S. The land capability classification is IVe. The Michigan soil management group is 3a. The primary habitat type is TM, and the secondary habitat type is ATD.

77D—Rock outcrop-Pemene complex, 6 to 18 percent slopes. This map unit occurs as areas of Rock outcrop and a gently rolling and rolling, well drained Pemene soil. The unit is on foot slopes, side slopes, and ridges in the uplands. Areas are about 40 to 50 percent Rock outcrop and 35 to 45 percent Pemene soil. The Rock outcrop and Pemene soil occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Pemene soil has a surface layer of black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam. In some places, the upper part of the soil is loamy fine sand and the lower part is fine sandy loam. In other places the soil is dominantly fine sandy loam and loam. In some areas it is stony or bouldery.

Included in this unit in mapping are small areas of Zimmerman, Mancelona, and Karlin soils. These soils are coarser textured than the Pemene soil. They are mainly on foot slopes and in valleys. Also included are small areas of Nadeau soils, generally on narrow, steep-sided ridges and small areas of the somewhat poorly drained Solona and Wainola, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways. Nadeau soils have more cobbles and stones in the substratum than the Pemene soil. Included soils make up about 20 to 25 percent of the unit.

Permeability is moderate or moderately rapid in the Pemene soil. The available water capacity is moderate. Surface runoff is medium.

This unit is used as woodland. The major management concern is the equipment limitation. The Rock outcrop severely limits the number of sites suitable for logging roads and landings and hinders harvesting activities. Careful planning of logging roads is needed because of the Rock outcrop. Landing sites may be available in the small included or adjacent areas of nearly level or undulating soils. Because of the Rock outcrop, trees generally are not planted on this unit.

The woodland ordination symbol assigned to the Pemene soil is 4S. The land capability classification is VIIe. The Michigan soil management group is 3a. The primary habitat type is TMV, and the secondary habitat type is AQVac.

77F—Rock outcrop-Pemene complex, 18 to 35 percent slopes. This map unit occurs as areas of Rock outcrop and a hilly, well drained Pemene soil. The unit is on hills and ridges in the uplands. Escarpments are common throughout the unit. Areas are about 45 to 55 percent Rock outcrop and 35 to 45 percent Pemene soil. The Rock outcrop and the Pemene soil occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Pemene soil has a surface layer of black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 2 inches thick. The subsoil is about 57 inches thick. The upper part is strong brown, very friable fine sandy loam. The next part is brown loamy fine sand and reddish brown fine sandy loam. The lower part is yellowish red loamy fine sand that has thin bands of reddish brown fine sandy loam. In some places, the upper part of the soil is loamy fine sand and the lower part is fine sandy loam. In other places the soil is dominantly fine sandy loam and loam. In some areas it is stony or bouldery.

Included in this unit in mapping are small areas of Zimmerman, Mancelona, and Karlin soils. These soils are coarser textured than the Pemene soil. They are mainly on foot slopes and in valleys. Also included are small areas of Nadeau soils, generally on narrow, steep-sided ridges and small areas of the somewhat poorly drained Solona and Wainola, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways. Nadeau soils have more cobbles and stones in the substratum than the Pemene soils. Included soils make up about 15 to 20 percent of the unit.

Permeability is moderate or moderately rapid in the Pemene soil. The available water capacity is moderate. Surface runoff is medium.

This unit is used as woodland. The major management concerns are the equipment limitation and the erosion hazard. The Rock outcrop severely limits the number of sites suitable for logging roads and landings and hinders harvesting activities. The slope limits the use of equipment and the number of suitable landing sites. Special care is needed in laying out logging roads and in operating the equipment. Careful planning of the logging roads is needed because of the Rock outcrop.

Erosion results from the concentration of runoff on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping road surfaces, culverts, and drop structures and building the roads on the contour or on the gentler slopes help to prevent excessive soil loss. Seeding logging areas and skid roads after the trees are logged helps to establish a protective plant cover. Because of the Rock outcrop, trees generally are not planted on this unit.

This unit is not suitable as cropland because of the Rock outcrop, the slope, and the hazard of water erosion.

The woodland ordination symbol assigned to the Pemene soil is 4R. The land capability classification is VIIe. The Michigan soil management group is 3a. The primary habitat type is TMV, and the secondary habitat type is AQVac.

79—Hettinger silt loam. This nearly level, poorly drained soil is on low flats and in depressions and drainageways. It is subject to ponding.

Typically, the surface layer is black silt loam about 6 inches thick. The subsoil is about 20 inches thick. It is mottled and firm. The upper part is dark gray and dark grayish brown silty clay loam, and the lower part is dark brown silt loam. The substratum to a depth of about 60 inches is brown, stratified silty clay loam and silt loam. In some areas layers of sand are in the substratum.

Included with this soil in mapping are small areas of the somewhat poorly drained Alstad and Solona soils on knolls and ridges. Also included are small areas of Cathro, Deford, and Ensley soils, which are in landscape positions similar to those of the Hettinger soil. Cathro soils have a thick layer of muck. Deford and Ensley soils are coarser textured than the Hettinger soil. Included soils make up about 10 to 15 percent of the unit.

Permeability is slow in the Hettinger soil. The available water capacity is high. Surface runoff is very slow or ponded. The seasonal high water table is near or above the surface from fall to spring.

This soil is used as woodland. The major management concerns are the equipment limitation, seedling mortality, and the windthrow hazard. The seasonal high water table restricts the use of equipment in late fall and in winter and spring. The equipment should be used only when the soil is dry or frozen or has an adequate snow cover. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and can alter soil structure. Because of the wetness, loss of seedlings can be more than 50 percent and the trees are shallow rooted. Many trees may be blown down during high winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Trees generally are not planted on this soil because of the wetness and low productivity.

The woodland ordination symbol is 6W. The land capability classification is Vw. The Michigan soil management group is 1.5c. The primary habitat type is TTM, and the secondary habitat type is TTS.

80B—Longrie fine sandy loam, 0 to 6 percent slopes. This moderately deep, nearly level and

undulating, well drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is brown and dark brown, friable fine sandy loam about 16 inches thick. Limestone bedrock is at a depth of about 21 inches. In some places the soil is moderately well drained. In other places it is less than 20 or more than 40 inches deep over bedrock. Some areas have a few rock outcrops. In places the bedrock is sandstone, granite, schist, or gneiss.

Included with this soil in mapping are small areas of the somewhat poorly drained Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways. These soils make up about 8 to 12 percent of the unit.

Permeability is moderate or moderately rapid in the Longrie soil. The available water capacity is low. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concern is the windthrow hazard. The equipment limitation is generally slight, but the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Bedrock and rock outcrops can hinder road construction in a few areas. Because of the depth to bedrock, the trees on this soil are shallow rooted. Some may be blown down during periods of soil wetness and strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, droughtiness, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion. Small grain crops planted in the fall or early spring can make good use of the limited amount of available water. A system of conservation tillage helps to control water erosion and soil blowing and helps to prevent crusting during periods of heavy rainfall. The soil can be irrigated if enough irrigation water is available. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3A. The land capability classification is IIIe. The Michigan soil management group is 3/Ra. The primary habitat type is AVO, and the secondary habitat type is ATD.

80D—Longrie fine sandy loam, 6 to 18 percent slopes. This moderately deep, gently rolling and rolling, well drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is brown and dark brown, friable fine sandy loam about 16 inches thick. Limestone bedrock is at a depth of about 21 inches. In places the depth to bedrock is less than 20 or more than 40 inches. In some areas the bedrock is sandstone, granite, schist, or gneiss.

Included with this soil in mapping are small areas of the somewhat poorly drained Solona, poorly drained Ensley, and very poorly drained Cathro soils in depressions and drainageways. Also included are some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate or moderately rapid in the Longrie soil. The available water capacity is low. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concerns are the windthrow hazard and the equipment limitation on landings and logging roads. The use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Bedrock and rock outcrops can hinder road construction in a few areas. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils. Because of the depth to bedrock, the trees on this soil are shallow rooted. Some may be blown down during periods of soil wetness and strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, droughtiness, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. Small grain crops planted in the fall and early spring can make good use of the limited amount of available water. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion, increases the moisture supply by increasing the rate of water infiltration, and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3A. The land capability classification is IVe. The Michigan soil management group is 3/Ra. The primary habitat type is AVO, and the secondary habitat type is ATD.

82B—Ubly Variant very fine sandy loam, 2 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats, knolls, and ridges in the uplands.

Typically, the surface layer is black very fine sandy loam about 5 inches thick. The subsurface layer is brown very fine sandy loam about 2 inches thick. The subsoil is very fine sandy loam about 16 inches thick. The upper part is dark brown and friable, and the lower part is brown and dark reddish brown and is firm. The substratum to a depth of about 60 inches is dark reddish brown clay loam. In some areas the soil is moderately well drained.

Included with this soil in mapping are scattered small areas of Emmet, Pemene, and Escanaba soils. These soils are coarser textured in the substratum than the Ubly Variant soil. They are in landscape positions similar to those of the Ubly Variant soil. Also included are small areas of the somewhat poorly drained Solona and poorly drained Ensley soils in drainageways and depressions and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Ubly Variant soil and slow in the lower part. The available water capacity is high. Surface runoff is slow.

Most areas of this soil are used as woodland. The major management concern is the windthrow hazard. Because of the firm subsoil, the trees on this soil are shallow rooted. Some may be blown down by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. The equipment limitation is generally slight, but the use of equipment may be limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3D. The land capability classification is IIe. The Michigan soil management group is 2.5a. The primary habitat type is AVO, and the secondary habitat type is ATD.

82D—Ubly Variant very fine sandy loam, 6 to 18 percent slopes. This gently rolling and rolling, well drained soil is on foot slopes, side slopes, and ridges in the uplands.

Typically, the surface layer is black very fine sandy loam about 5 inches thick. The subsurface layer is brown very fine sandy loam about 2 inches thick. The subsoil is very fine sandy loam about 16 inches thick. The upper part is dark brown and friable, and the lower part is brown and dark reddish brown and is firm. The substratum to a depth of about 60 inches is dark reddish brown clay loam. In some areas the soil is moderately well drained.

Included with this soil in mapping are scattered small areas of Emmet, Pemene, and Escanaba soils. These soils are coarser textured in the substratum than the Ubly Variant soil. They are in landscape positions similar to those of the Ubly Variant soil. Also included are small areas of the somewhat poorly drained Solona and poorly drained Ensley soils in depressions and drainageways and some areas that have a few rock outcrops. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Ubly Variant soil and slow in the lower part. The available water capacity is high. Surface runoff is medium.

Most areas of this soil are used as woodland. The major management concern is the windthrow hazard. Because of the firm subsoil, the trees on this soil are shallow rooted. Some may be blown by strong winds. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. The equipment limitation is generally slight but is severe on sites for landings. Also, the use of equipment may be briefly limited in the spring and in other excessively wet periods. During these periods, unsurfaced roads tend to be slippery and ruts form easily. Graveling the logging roads facilitates year-round use. Suitable landing sites may be available in the small included or adjacent areas of nearly level or undulating soils.

If this soil is cultivated, the major management concerns are water erosion, soil blowing, and tilth. Contour tillage and contour stripcropping slow runoff. Grassed waterways, diversions, and drop structures help to prevent gullying. Crop residue management and a cropping sequence that includes close-growing crops help to control water erosion and soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and helps to prevent crusting during periods of heavy rainfall. Minimizing tillage and tilling at the proper soil

moisture content help to prevent excessive compaction. Returning crop residue to the soil, adding other organic material, and including grasses and legumes in the cropping sequence improve soil structure, fertility, water infiltration, and permeability. Field windbreaks, buffer strips, and cover crops, such as rye, help to control soil blowing.

The woodland ordination symbol is 3D. The land capability classification is IVe. The Michigan soil management group is 2.5a. The primary habitat type is AVO, and the secondary habitat type is ATD.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 71,000 acres in the survey area, or about 15 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in associations 1, 2, and 4, which are described under the heading "General Soil Map Units."

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, foresters, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to various interpretive groups at the end of each map unit description and in some of the tables. The groups for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops and Pasture

Dwight L. Quisenberry, agronomist, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

The field crops commonly grown in the county are potatoes, corn, and oats. Rye and barley are grown on smaller acreages. Alfalfa is the chief legume. The main grasses grown for hay and pasture are bromegrass and timothy. Birdsfoot trefoil, wheat, buckwheat, sorghum, sudangrass, and orchardgrass are not commonly grown in the county, but they can be grown if economic conditions are favorable.

Specialty crops are grown commercially in the county on a very limited basis. Small acreages are used for strawberries, cabbage, sod, and a small number of landscape nurseries and Christmas tree plantations. The latest information about growing specialty crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Cropland

Food production could be increased by applying measures that conserve soil and water and by extending the latest crop production technology to all of the cropland in the county. The paragraphs that follow describe the main concerns in managing the cropland in the county.

Water erosion is a major problem on much of the cropland in the county. Loss of topsoil is important for several reasons. Productivity is reduced as the surface soil is lost and more of the subsoil is mixed into the plow layer. The subsoil in most of the soils used for crops and pasture in Dickinson County is generally lower in content of organic matter than the original surface soil, is higher

in content of sand, and has a lower available water capacity. Also, tilth is poorer. Exposure of the subsoil can increase the hazard of soil blowing.

Water erosion can result in sedimentation of ditches and streams. The sediment can obstruct tile drainage outlets and thus reduce the effectiveness of the drainage systems. If it enters streams, sediment that contains fertilizer and pesticides can reduce the quality of water.

Erosion control provides a protective ground cover, reduces the runoff rate, and increases the rate of water infiltration. A cropping system that keeps a vegetative cover on the soil for extended periods can hold soil losses to amounts that will not reduce the productive capacity of the soil. On livestock farms, where hay and pasture are needed, including grasses and legumes in the cropping sequence not only helps to control erosion on the more sloping land but also provides nitrogen and improves tilth for the following crop.

A system of conservation tillage that leaves crop residue on the surface increases the rate of water infiltration and reduces the hazards of runoff and erosion. No-till cropping systems require high levels of management. Herbicides and insecticides are used to control weeds, insects, and pests. No-till farming is especially effective in minimizing erosion on the undulating and rolling soils in the county.

Contour stripcropping is effective in controlling erosion (fig. 9). It is not effective, however, in areas where slopes are too complex.

Grassed waterways are commonly used to control erosion in the county. A permanent vegetative cover is maintained in areas where surface runoff concentrates. Subsurface drains are installed below many of the waterways to remove excess internal water. Drainage of excess water enhances the growth of desirable plants and facilitates the use of machinery.

Figure 9.—Contour stripcropping in an area of Emmet fine sandy loam, 0 to 6 percent slopes.

Grade stabilization structures control erosion where surface water drains into channels. These structures commonly are used in conjunction with grassed waterways, at both the outlet and the inlet ends. Grade stabilization structures allow water to drop to a lower elevation while preventing excessive erosion of the sides and bottom of the channels.

Soil blowing is a hazard on most of the unprotected soils in the county. It can be controlled by maintaining a cover of vegetation or mulch, alternating strips of row crops with strips of hay or small grain, planting small grain buffer strips, leaving crop residue on the surface, and keeping the surface rough through proper tillage methods. It also can be controlled by vegetative barriers and by field windbreaks of adapted trees and shrubs planted at right angles to the prevailing wind.

Wetness is a limitation on some of the cropland in the county. Some areas of the poorly drained Ensley soils are adequately drained. Most areas of these soils and of other poorly drained or very poorly drained soils, however, cannot be economically drained. They are on low plains and in low depressions where ponding frequently occurs and where suitable drainage outlets are not readily available. Also, low soil temperature in these areas hinder seed germination, and extended periods of frost can occur. In areas of Solona, Alstad, Channing, Wainola, and other somewhat poorly drained soils, a drainage system is needed. Tillage, seed germination, and plant growth are adversely affected unless excess water is removed from these areas.

Small areas of wetter soils along drainageways and in swales are commonly included with the well drained soils in mapping. Fieldwork is delayed in some of these areas unless a drainage system is installed.

Subsurface tile drainage systems are the primary methods of removing excess water. Spacing of the tile drains should be based on the permeability of the soils. In some areas open ditches are used as outlets for the tile drains.

Soil fertility is naturally low in sandy soils and medium in most of the loamy soils in the county. It currently varies because of differences in past land use and management practices. In most areas the surface soil is medium acid to neutral. Additions of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kind and amount of fertilizer and lime to be applied.

Soil tilth is an important factor affecting the germination of seeds, seedling emergence, the available water capacity, the susceptibility to water erosion and soil blowing, and the movement of water into and within the soil. Soils with good tilth have good structure and generally have a moderate or high content of organic matter in the surface layer.

The use of machinery on wet soils, excessive tillage, the beating action of raindrops on bare soil, and depletion of the organic matter in the soil can destroy soil structure and result in compaction and surface crusting. Under these conditions, the ability of the soil to absorb and store water for plant use is reduced and the runoff rate increases. As soil structure is destroyed, small individual soil particles are formed. These can be easily carried away by wind and water. In areas where soil structure is poor, a crust forms at the surface and large clods can form. The crust can hinder the emergence of seedlings. Cloddiness is common in severely eroded, loamy soils. Seed germination commonly is poor in these soils because the soil-seed contact is not sufficient to supply the required amount of water. An adequate drainage system, timely fieldwork, conservation tillage, erosion control, and measures that maintain the content of organic matter improve tilth.

Droughtiness is a limitation on much of the cropland in the county. Many of the soils can be irrigated. Irrigation not only supplies additional water and plant nutrients but also can protect the crops from the damage caused by frost.

Further information about managing cropland is available at local offices of the Cooperative Extension Service and the Soil Conservation Service.

Pasture

Much of the permanent pasture in the county is in areas where water erosion is a hazard. Control of erosion is particularly important when the pasture is seeded. Measures that prevent overgrazing help to protect the plant cover and thus help to control water erosion. The need for lime and fertilizer should be determined by soil tests.

Many pastures are in areas of wet soils. Grazing when the soils are wet results in compaction and thus in decreased forage production. A drainage system and restricted grazing when the soils are wet minimize compaction.

The productivity of a pasture and its ability to protect the soil are influenced by the number of livestock in the pasture, the length of time that they graze, and the distribution of rainfall. Good pasture management includes proper stocking rates, pasture rotation, and deferred grazing.

Further information about managing pasture is available at local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 7. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table. Also given at the end of each map unit description is a Michigan soil management group (*7*). The soils are assigned to a group according to the need for lime and fertilizer and for artificial drainage and other practices.

Woodland Management and Productivity

William E. Frederick, forest soils specialist, helped prepare this section.

A total of about 458,000 acres, or 92 percent of the survey area, is woodland. About 200,000 acres is owned by the state. A number of corporations own large parcels of woodland, and individuals own many small parcels.

Stands on upland soils are dominantly aspen and northern hardwoods, namely, sugar maple, basswood, yellow birch, and red oak. Black cherry, white pine, red pine, balsam fir, and white spruce also are in some

stands. Scattered areas support stands of jack pine, red pine, and white pine. Stands on the wetter sites are dominantly red maple, quaking aspen, balsam poplar, and balsam fir.

Stands on soils in swamps are mostly balsam fir, black spruce, northern white-cedar, and tamarack. Red maple, quaking aspen, paper birch, and black ash are in some stands.

In 1980, the composition of the forest species, by forest type, was 34.4 percent aspen and white birch; 29.9 percent balsam fir, black spruce, northern white-cedar, and tamarack; 27.9 percent sugar maple, basswood, yellow birch, and other upland hardwoods; 3.5 percent red maple, black ash, and other lowland hardwoods; 2.2 percent red pine, white pine, and jack pine; 1.3 percent white spruce; and 0.8 percent nonstocked areas (*8*). The growing stock had a volume of 383,517,000 cubic feet in 1980. In 1979, annual growth was 15,795,000 cubic feet. About 9,415,000 cubic feet was removed. Sawtimber had a volume of 698,953,000 board feet in 1980. In 1979, annual growth was 47,262,000 board feet. About 19,520,000 board feet was removed (*8*).

Management of the different kinds of soil in the survey area for wood crops varies. It generally is governed by the species in the stand. For example, one management alternative may be selective harvesting that favors hardwood species. Another management alternative may be even-aged management that favors aspen and white birch (fig. 10). Other management alternatives can favor northern white-cedar for the production of posts and piles or balsam fir for pulpwood. Management should include controlling erosion, planting trees where natural regeneration is undesirable or insufficient, controlling plant competition, improving seedling survival, minimizing windthrow on the wetter sites, timely harvesting, controlling the damage caused by insects and diseases, removing cull trees and undesirable species, and maintaining an optimum basal area.

Soil erosion can occur as a result of site preparation and cutting if the soil is exposed along logging roads, skid roads, and fire lanes and in landing areas. Burned areas also are subject to erosion. Erosion is generally a hazard on forest land if the slope of the soil is 18 percent or more. Building logging roads and skid roads on the contour minimizes erosion.

Soil wetness is the result of a high water table, flooding, or ponding. It causes seedling mortality, limits the use of equipment, increases the extent of undesirable plants following harvest, and increases the windthrow hazard by restricting the rooting depth of some trees. Ruts form easily on some soils if wheeled skidders are used when the soil is wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Also, they can result in a change in species composition and can reduce yields. On all of the wet soils, equipment should be used only during dry periods or when the ground is frozen or has an adequate snow cover.

Soil droughtiness can cause seedling mortality. The steeper south- and west-facing slopes can be especially droughty because of high soil temperatures and the evaporation rate. Planting when the soils are moist can reduce the seedling mortality rate. Seedling survival during dry periods can be improved by planting large, vigorous nursery stock if natural regeneration is undesirable or insufficient. Special site preparation, such as furrowing to conserve moisture, may also be needed. Containerized planting stock may be needed on very dry sites.

Slope, stoniness, and *rock outcrops* can limit the use of forestry equipment. A slope of 18 percent or more generally limits the use of equipment in logging areas, on skid roads, and on logging roads. Building the logging roads and skid roads on the contour helps to overcome this limitation. The slope also affects the selection of sites for landings and log-handling areas. Nearly level and undulating areas are the best sites. Stones, rock outcrops, and a shallow depth to bedrock not only restrict the use of equipment but also hinder the construction of logging roads. Careful planning of proposed logging roads can avoid most of these obstacles.

Tables 8 and 9 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. Table 8 lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; and *F*, a high content of rock fragments in the soil. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, and F.

In table 8, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned

Figure 10.—A 7-year-old, nearly pure stand of aspen on Emmet fine sandy loam, 0 to 6 percent slopes. The former stand of even-aged mixed northern hardwoods and aspen was clearcut.

or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality

are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced on a fully stocked, even-aged, unmanaged stand. The volume was determined through the use of standard yield tables (*11*).

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Table 9 gives information about operating harvesting or thinning equipment in logging areas and on skid trails, landings, and logging roads. Limitations are given for the most limiting season and for the preferred season. The *most limiting season* in Dickinson County generally is spring or late fall. In some areas, however, it is during dry periods in summer, when loose sand can limit trafficability on deep, well drained, sandy soils. The *preferred operating season* is the period when harvesting or thinning causes the least amount of soil damage. This period generally is when the soil is not too wet or when the ground is frozen or partly frozen or has an adequate snow cover.

In table 9 a rating of *slight* indicates that the use of conventional logging equipment is not restricted if normal logging methods are used. A rating of *moderate* indicates that the use of equipment is restricted because of one or more soil factors. If wetness is a limitation, high flotation equipment or special procedures may be needed to prevent the formation of ruts. A rating of *severe* indicates that the kind of equipment that can be used is seriously restricted.

Logging areas and skid trails include areas where some or all of the trees are being cut. Generally, equipment traffic is least intensive in the logging areas. Skid trails, which generally are within the logging area, are roads or trails over which logs are dragged or hauled from the stump to a log landing.

Landings are areas where logs are assembled for transportation (fig. 11). Wheeled equipment may be used more frequently in these areas than in any other areas affected by logging.

Logging roads are access roads leading from primary or surfaced roads to the logging areas. The logging roads serve as transportation routes for wheeled logging equipment and logging trucks. Generally, they are unpaved roads. Some are graveled.

Forest Habitat Types

The information in this section is derived from a field guide developed for the Upper Peninsula of Michigan and for northeast Wisconsin (*4*). The system of habitat classification used in the guide is based on the concept that plants occur in predictable patterns or communities and that these communities reflect differences in site characteristics.

Besides identifying the various habitat types by means of vegetative keys, the guide also provides information about the different possible successional stages for most of the habitat types. The successional stages depend largely on how the forest has been disturbed. They include the succession after logging in the original climax stands, the succession after logging in second-growth stands, and the succession in stands that have been both logged and burned.

The guide gives the suggested forest management for each of the successional stages. This management includes methods of thinning and harvest, site preparation, and measures that improve regeneration of the stands. The potential productivity, in terms of a site index and the mean annual volume in cubic feet per acre per year, is given for most of the habitat types. The development of the descriptive or interpretative information for some of the habitat types, however, is

Figure 11.—A landing in an area of Emmet fine sandy loam, 0 to 6 percent slopes.

based on limited data and thus should be used with caution.

Habitat types have been determined for each map unit in the survey area. The primary habitat type is the one that is most common on the map unit. The secondary habitat type is less common. Habitat types are specified at the end of the descriptions in the section "Detailed Soil Map Units." They also are specified in the section "Interpretive Groups," which follows the tables at the back of this survey.

The following paragraphs describe the habitat types in the survey area. They provide information about the potential climax species, some of the common understory species, and, if known, the potential productivity of the habitat type.

AOC—Acer-Osmorhiza-Caulophyllum habitat type. This habitat type has a potential climax overstory dominated by sugar maple. Other species include eastern hemlock and American basswood. American elm, white ash, and eastern hophornbeam are in some areas. The dominant ground flora includes spinulose woodfern, blue cohosh, sweet cicely, common ladyfern, smooth yellow violet, Canada white violet, and downy yellow violet. The potential productivity for northern hardwoods is high.

AQVac—Acer-Quercus-Vaccinium habitat type. This habitat type has a potential climax overstory dominated by red maple and red oak. Other species include eastern hemlock, white pine, balsam fir, and white spruce. The dominant ground flora includes lowbush blueberry, Canada blueberry, brackenfern, wintergreen, bigleaf aster, and hazelnut. The potential productivity is moderately low for northern hardwoods, moderate for aspen, and moderately high for red pine and jack pine.

ATD—Acer-Tsuga-Dryopteris habitat type. This habitat type has a potential climax overstory dominated by sugar maple. Other species include eastern hemlock, American basswood, and American beech. Yellow birch, red maple, and American elm are in some areas. The dominant ground flora includes spinulose woodfern, rosy twistedstalk, hairy Solomons-seal, scarlet elder, and Canada mayflower. The potential productivity is moderately high for northern hardwoods and high for aspen. The potential productivity for red pine plantations is high if plant competition is controlled.

AVO—Acer-Viola-Osmorhiza habitat type. This habitat type has a potential climax overstory dominated by sugar maple. Other species include American basswood, white ash, yellow birch, eastern hophornbeam, eastern hemlock, and American elm. The dominant ground flora includes smooth yellow violet, Canada white violet, downy yellow violet, sweet cicely, spinulose woodfern, common ladyfern, hairy Solomons-seal and rosy twistedstalk. The potential productivity is high for northern hardwoods and aspen. It also is high for red pine plantations if plant competition is controlled.

AVO-A—Acer-Viola-Osmorhiza, Adiantum phase habitat type. This habitat type has a potential climax overstory dominated by sugar maple. Other species include American basswood, white ash, yellow birch, eastern hophornbeam, eastern hemlock, and American elm. The dominant ground flora includes smooth yellow violet, Canada white violet, downy yellow violet, sweet cicely, American maidenhair fern, wild leek, spinulose woodfern, common ladyfern, hairy Solomons-seal and rosy twistedstalk. The potential productivity is high for northern hardwoods and aspen. It also is high for red pine plantations if plant competition is controlled.

FMC—Fraxinus-Mentha-Carex habitat type. This habitat type has a potential climax overstory dominated by black ash and American elm. Other species include red maple and balsam fir. The dominant ground flora includes sedge, mint, speckled alder, and spotted touchmenot.

FMC-C—Fraxinus-Mentha-Carex, Carex phase habitat type. This habitat type has a potential climax overstory dominated by black ash and American elm. Other species include red maple and balsam fir. The dominant ground flora includes sedge, field mint, speckled alder, and spotted touchmenot. This phase is mostly limited to active flood plains where trees generally do not grow.

PCS—Picea-Chamadaphne-Sphagnum habitat type. This habitat type has a potential climax overstory dominated by black spruce. Other species include tamarack. Northern white-cedar is in some stands. The dominant ground flora includes leatherleaf, bog rosemary, pale laurel, sphagnum, Labrador tea, sedge, and Canada blueberry.

TM—Tsuga-Maianthemum habitat type. This habitat type has a potential climax overstory dominated by eastern hemlock, sugar maple, and red maple. Other species include yellow birch. White spruce, balsam fir, white pine, red oak, northern white-cedar, and American basswood are in some areas. The dominant ground flora includes Canada blueberry, wild sarsaparilla, brackenfern, Canada mayflower, lowbush blueberry, yellow beadlily, and wood betony. The potential productivity is moderate for northern hardwoods, moderately high for aspen, and high for red pine and jack pine.

TMC—Tsuga-Maianthemum-Coptis habitat type. This habitat type has a potential climax overstory dominated by eastern hemlock and red maple. Other species include sugar maple and yellow birch. Balsam fir, white spruce, and northern white-cedar are in some areas. The dominant ground flora consists of Canada mayflower, goldthread, yellow beadlily, bunchberry dogwood, American starflower, and spinulose woodfern. The potential productivity is moderate for northern hardwoods.

TMC-V—Tsuga-Maianthemum-Coptis, Vaccinium phase habitat type. This habitat type has a potential climax overstory dominated by eastern hemlock and red maple. Other species include sugar maple and yellow birch. Balsam fir, white spruce, and northern white-cedar are in some areas. The dominant ground flora consists of Canada mayflower, goldthread, yellow beadlily, bunchberry dogwood, American starflower, and spinulose woodfern. The potential productivity is moderate for northern hardwoods.

TMV—Tsuga-Maianthemum-Vaccinium habitat type. This habitat type has a potential climax overstory dominated by eastern hemlock and red maple. Other species include sugar maple, white pine, balsam fir, and white spruce. Red oak is in some stands. The dominant ground flora includes Canada blueberry, wild sarsaparilla, brackenfern, Canada mayflower, lowbush blueberry, yellow beadlily, and wood betony. The potential productivity is moderate for northern hardwoods, moderately high for aspen, and high for red pine and jack pine.

TTM—Tsuga-Thuja-Mitella habitat type. This habitat type has a potential climax overstory dominated by northern white-cedar and eastern hemlock. Other species include balsam fir and red maple. The dominant ground flora consists of naked miterwort, sedge, Canada mayflower, American starflower, northern twinflower, and bunchberry dogwood.

TTS—Tsuga-Thuja-Sphagnum habitat type. This habitat type has a potential climax overstory dominated by eastern hemlock and northern white-cedar. Other species include balsam fir and black spruce. Red maple is in some stands. The dominant ground flora includes sphagnum, goldthread, bunchberry dogwood, sedge, Canada mayflower, American starflower, and wood sorrel.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 10 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 10 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Much of the acreage in Dickinson County is used for such recreational activities as fishing, hunting, sightseeing, and nature study. Winter recreational activities include cross-country skiing and snowmobiling. Some areas are developed for intensive recreational uses. These include campgrounds, picnic areas, playgrounds, hiking trails, downhill skiing areas, and golf courses. Because of an increasing population and increasing land prices, more land is likely to be developed for recreational uses in the future.

The soils of the survey area are rated in table 11 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 11, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 11 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 14 and interpretations for dwellings without basements and for local roads and streets in table 13.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Dickinson County has many kinds of wildlife habitat. Woodland habitat supports lowland conifers (northern white-cedar, balsam fir, black spruce, and tamarack), lowland hardwoods (black ash and red maple), upland conifers (white spruce, balsam fir, jack pine, white pine, and red pine), upland hardwoods (sugar maple,

basswood, red oak, and yellow birch), and aspen. Large areas support lowland shrubs (speckled alder, willow, sweet gale, and dwarf birch) and acid-tolerant bog vegetation (leatherleaf, pale laurel, and Labrador tea), and smaller areas support marsh vegetation (cattails and reeds). Both artificial and natural flooding provide many shallow water areas. Once cleared for use as pasture or cultivated crops, openings in the woodland support wild grasses and herbaceous plants (fig. 12). These openings and the areas used for pasture or cultivated crops provide some openland habitat.

In many areas the habitat can be improved by increasing the supply of available food, water, and cover. Measures that increase habitat diversity are needed. An example is planting grasses, small grain, or food-producing shrubs in a woodland opening. Establishing the woodland opening near an area of wetland further enhances the variety of wildlife species.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 12, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

Figure 12.—An opening in a wooded area of the Emmet-Carbondale-Cathro association.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, timothy, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bunchberry dogwood, goldenrod, sweet cicely, hairgrass, and strawberry.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, aspen, cherry, maple, apple, hawthorn, dogwood, raspberry, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are swamp milkweed, spotted joepyeweed, wildrice, marshmarigold, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include sharp-tailed grouse, kestrel, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, porcupine, raccoon, deer, and bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils

may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 13 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic

matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 14 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 14 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 14 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 14 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over

bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 15 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 15, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 16 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

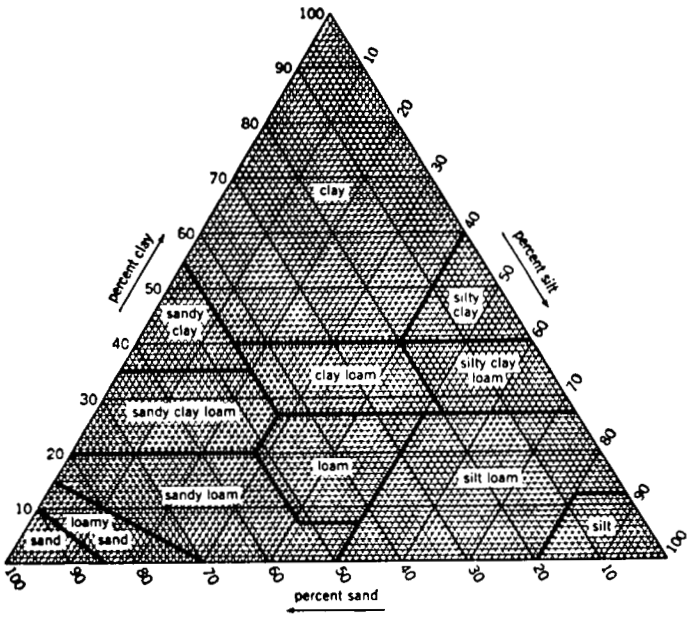

Figure 13.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 17 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 13). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of

grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 18 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to

buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 18, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 19 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 19, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 19 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 19 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 19.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Characterization Data for Selected Soils

Some of the soils in Dickinson County were sampled for physical and chemical analyses by the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan (*6*). The laboratory data obtained from the soil samples include analyses of particle-size distribution, coarse fragments, bulk density, and moisture retention. Complete chemical analyses were also performed on each sample, and

spodic horizon criteria were determined on the appropriate samples. Standard National Cooperative Soil Survey procedures were used for all analyses. Forest sites also were sampled for an estimate of the productivity of many of the soils for wood products.

These data were used in classifying and correlating the soils and in evaluating their behavior, especially under forestry uses. Five profiles were selected as representative of their respective series. These series and their laboratory identification numbers are as follows: Emmet (S81MI-43-2), Escanaba (S82MI-43-5), Mancelona (S81MI-43-7), Pemene (S82MI-43-4), and Rubicon (S81MI-43-8).

In addition to the Dickinson County data, soil characterization data and forest site data are available from nearby counties having some of the same soils as Dickinson County. These data and the Dickinson County data are available at the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan; the Soil and Water Conservation Division, Michigan Department of Agriculture, Lansing, Michigan; and the Soil Conservation Service, State Office, East Lansing, Michigan.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*10*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Spodosol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Orthod (*Orth*, meaning the common ones, plus *od*, from Spodosol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplorthods (*Hapl*, meaning minimal horizonation, plus *orthod*, the suborder of the Spodosols that has a horizon characterized by an accumulation of aluminum, iron, and organic carbon in which no one of the elements dominates).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Entic* identifies the subgroup that typifies the great group. An example is Entic Halplorthods.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is sandy, mixed, frigid Entic Haplorthods.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*9*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*10*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Alstad Series

The Alstad series consists of somewhat poorly drained soils on till plains and moraines. These soils formed in loamy glacial till. Permeability is moderate in the solum and moderately slow in the substratum. Slopes range from 0 to 6 percent.

Alstad soils are similar to Hettinger soils and are commonly adjacent to Carbondale, Cathro, Emmet, and Pemene soils. Hettinger soils are poorly drained. Carbondale and Cathro soils are very poorly drained and

are lower on the landscape than the Alstad soils. Emmet and Pemene soils are well drained and are higher on the landscape than the Alstad soils.

Typical pedon of Alstad loam, 0 to 6 percent slopes, 1,400 feet east and 1,060 feet south of the northwest corner of sec. 6, T. 43 N., R. 30 W.

A—0 to 4 inches; dark reddish brown (5YR 3/2) loam, gray (5YR 6/1) dry; weak medium granular structure; friable; about 2 percent pebbles; medium acid; abrupt wavy boundary.

Bs—4 to 16 inches; dark brown (7.5YR 4/4) loam; common fine distinct brown (7.5YR 5/2) mottles; weak fine subangular blocky structure; friable; about 2 percent pebbles; medium acid; abrupt wavy boundary.

E—16 to 21 inches; grayish brown (10YR 5/2) fine sandy loam; few fine distinct light brown (7.5YR 6/4) mottles; massive; firm; about 2 percent pebbles; slightly acid; abrupt wavy boundary.

B/E—21 to 26 inches; dark reddish brown (5YR 3/4) clay loam (Bt); common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; grayish brown (10YR 5/2) fine sandy loam (E); moderate medium subangular blocky structure; friable; about 3 percent pebbles; slightly acid; clear wavy boundary.

Bt—26 to 42 inches; dark reddish brown (5YR 3/4) clay loam; common fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; dark reddish brown (5YR 3/3) clay films on faces of peds; about 3 percent pebbles; neutral; clear wavy boundary.

C—42 to 60 inches; reddish brown (5YR 4/3) clay loam; massive; firm; about 3 percent pebbles and cobbles; slight effervescence; moderately alkaline.

The solum is 24 to 56 inches thick. The content of pebbles is 0 to 15 percent throughout the profile. The content of coarse fragments larger than 3 inches is 0 to 2 percent in the C horizon.

Some pedons have a thin Oe horizon. The A, Bs, and E horizons are loam, fine sandy loam, or sandy loam. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 1 to 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. The E horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 or 3. The Bt horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is loam or clay loam. The C horizon is sandy loam, loam, or clay loam. Some pedons do not have free carbonates.

Carbondale Series

The Carbondale series consists of very poorly drained, organic soils on low flats and in depressions. These soils formed in decomposed herbaceous and woody plant remains. Permeability is moderately slow to moderately rapid. Slopes are 0 to 1 percent.

Carbondale soils are commonly adjacent to Cathro, Emmet, Ensley, and Pemene soils. Cathro soils are organic to a depth of less than 51 inches. They are in landscape positions similar to those of the Carbondale soils. Emmet and Pemene soils are well drained and are higher on the landscape than the Carbondale soils. Ensley soils are poorly drained and are generally slightly higher on the landscape than the Carbondale soils. They have no organic layers or have a thin organic surface layer.

Typical pedon of Carbondale muck, in an area of Carbondale and Cathro mucks, 1,440 feet east of the northwest corner of sec. 16, T. 43 N., R. 29 W.

Oa—0 to 8 inches; sapric material, black (N 2/0) broken face and rubbed; about 45 percent fiber, less than 5 percent rubbed; weak medium granular structure; friable; primarily herbaceous material; mildly alkaline; abrupt smooth boundary.

Oe—8 to 23 inches; hemic material, black (N 2/0) broken face and rubbed; about 40 percent fiber, 25 percent rubbed; weak fine subangular blocky structure; friable; common woody fragments; primarily woody material; mildly alkaline; clear smooth boundary.

O'a—23 to 60 inches; sapric material, black (N 2/0) broken face and rubbed; about 15 percent fiber, less than 5 percent rubbed; massive; friable; primarily herbaceous material; mildly alkaline.

The organic material is more than 51 inches thick. It has hue of 5YR, 7.5YR, or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. Woody fragments are throughout some pedons. Some pedons have a fibric surface layer, which is 1 to 3 inches thick. Some or all of the organic material below a depth of 36 inches is hemic in some pedons.

Cathro Series

The Cathro series consists of very poorly drained, organic soils on low flats and in depressions. These soils formed in decomposed herbaceous and woody plant remains. Permeability is moderately slow to moderately rapid in the upper part of the profile and moderate or moderately slow in the lower part. Slopes are 0 to 1 percent.

Cathro soils are similar to Waucedah soils and are commonly adjacent to Carbondale, Emmet, Pemene, and Waucedah soils. Waucedah soils are organic to a depth of less than 16 inches. They are generally closer to streams than the Cathro soils. Carbondale soils are organic to a depth of more than 51 inches. They are in landscape positions similar to those of the Cathro soils.

Emmet and Pemene soils are well drained and are higher on the landscape than the Cathro soils.

Typical pedon of Cathro muck, in an area of Carbondale and Cathro mucks, 1,075 feet north and 1,075 west of the southeast corner of sec. 4, T. 39 N., R. 30 W.

Oa1—0 to 8 inches; sapric material, black (5YR 2/1) broken face and rubbed; about 30 percent fiber, less than 5 percent rubbed; weak fine granular structure; friable; herbaceous and woody material; neutral; clear wavy boundary.

Oa2—8 to 20 inches; sapric material, dark reddish brown (5YR 2/2) broken face and rubbed; about 50 percent fiber, less than 5 percent rubbed; weak medium platy structure; friable; primarily herbaceous material; neutral; gradual wavy boundary.

Oa3—20 to 43 inches; sapric material, dark reddish brown (5YR 2/2) broken face and rubbed; about 30 percent fiber, less than 5 percent rubbed; weak medium subangular blocky structure; friable; primarily herbaceous material; neutral; abrupt smooth boundary.

Cg1—43 to 51 inches; brown (7.5YR 4/2) very fine sandy loam; massive; friable; mildly alkaline; clear wavy boundary.

Cg2—51 to 60 inches; brown (7.5YR 4/2) stratified fine sandy loam and loamy sand; massive; friable; mildly alkaline.

The depth to the loamy C horizon is 16 to 50 inches. The organic material has hue of 5YR, 7.5YR, or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. In some pedons it has woody fragments throughout. Some pedons have a fibric surface layer, which is 1 to 3 inches thick. Some have thin layers of hemic material. The C horizon is sandy loam, fine sandy loam, very fine sandy loam, loam, or clay loam. In some pedons it has free carbonates.

Channing Series

The Channing series consists of somewhat poorly drained soils on outwash plains and stream terraces. These soils formed in loamy glacial drift over sandy glacial outwash and alluvium. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 3 percent.

Channing soils are similar to Solona soils and are commonly adjacent to Oconto, Pemene, Pence, and Vilas soils. Solona soils do not have a gravelly sand substratum. Oconto, Pemene, Pence, and Vilas soils are higher on the landscape than the Channing soils. Oconto, Pemene, and Pence soils are well drained, and Vilas soils are excessively drained.

Typical pedon of Channing fine sandy loam, 0 to 3 percent slopes, 2,500 feet south and 1,000 feet west of the center of sec. 2, T. 39 N., R. 31 W.

A—0 to 5 inches; dark reddish brown (5YR 2/2) fine sandy loam, reddish gray (5YR 5/2) dry; weak fine granular structure; friable; medium acid; abrupt wavy boundary.

Bs1—5 to 13 inches; dark reddish brown (5YR 3/4) fine sandy loam; common medium prominent yellowish red (5YR 4/8) mottles; weak medium subangular blocky structure; friable; medium acid; clear wavy boundary.

Bs2—13 to 23 inches; reddish brown (5YR 4/4) fine sandy loam; common fine prominent yellowish red (5YR 5/8) mottles; very weak fine subangular blocky structure; very friable; medium acid; abrupt wavy boundary.

2C—23 to 60 inches; light brown (7.5YR 6/4) stratified sand, gravelly sand, and very gravelly sand; single grain; loose; about 30 percent pebbles and cobbles; slightly acid.

The solum is 20 to 30 inches thick. The content of pebbles and cobbles is 0 to 10 percent in the solum and 15 to 40 percent in the 2C horizon.

Some pedons have a thin Oe horizon. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 1 or 2. Some pedons have an E horizon. This horizon is fine sandy loam 2 to 4 inches thick. It has hue of 5YR, value of 5, and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4 to 6.

Dawson Series

The Dawson series consists of very poorly drained, organic soils in bogs. These soils formed in decomposed herbaceous plant remains. Permeability is moderately slow to moderately rapid in the upper part of the profile and rapid in the lower part. Slopes are 0 to 1 percent.

Dawson soils are similar to Greenwood soils and are commonly adjacent to Greenwood, Pemene, Rubicon, and Wainola soils. Greenwood soils are organic to a depth of more than 51 inches. Pemene, Rubicon, and Wainola soils are higher on the landscape than the Dawson soils. Pemene soils are well drained, Rubicon soils are excessively drained, and Wainola soils are somewhat poorly drained.

Typical pedon of Dawson peat, in an area of Greenwood and Dawson peats, 1,200 feet east and 2,400 feet north of the southwest corner of sec. 27, T. 44 N., R. 30 W.

Oi—0 to 8 inches; fibric material, brown (10YR 4/3) broken face and rubbed; about 95 percent fiber, 85 percent rubbed; massive; friable; primarily sphagnum material; extremely acid; gradual wavy boundary.

Oe—8 to 13 inches; hemic material, dark brown (7.5YR 3/2) broken face, very dark brown (7.5YR 2/2) rubbed; about 80 percent fiber, 45 percent rubbed;

massive; friable; primarily herbaceous material; extremely acid; gradual wavy boundary.
Oa1—13 to 22 inches; sapric material, black (10YR 2/1) broken face, black (N 2/0) rubbed; about 25 percent fiber, less than 5 percent rubbed; massive; friable; primarily herbaceous material; extremely acid; clear wavy boundary.
Oa2—22 to 30 inches; sapric material, black (10YR 2/1) broken face, black (N 2/0) rubbed; about 40 percent fiber, less than 5 percent rubbed; massive; friable; primarily herbaceous material; extremely acid; abrupt smooth boundary.
C1—30 to 42 inches; pale brown (10YR 6/3) fine sand; massive; very friable; very strongly acid; gradual wavy boundary.
C2—42 to 60 inches; brown (10YR 4/3) loamy fine sand; massive; very friable; medium acid.

The depth to the C horizon is 16 to 50 inches. The organic material has hue of 5YR, 7.5YR, or 10YR, value of 2 to 4, and chroma of 1 to 3. The C horizon is sand, fine sand, or loamy fine sand.

Deford Series

The Deford series consists of poorly drained, rapidly permeable soils on outwash plains. These soils formed in sandy glacial outwash. Slopes are 0 to 1 percent.

Deford soils are similar to Kinross soils and are commonly adjacent to Cathro, Rousseau, Rubicon, and Wainola soils. Kinross soils have a spodic horizon and are more acid than the Deford soils. The organic Cathro soils are very poorly drained and are generally slightly lower on the landscape than the Deford soils. Rousseau, Rubicon, and Wainola soils are higher on the landscape than the Deford soils. Rousseau soils are well drained or moderately well drained, Rubicon soils are excessively drained, and Wainola soils are somewhat poorly drained.

Typical pedon of Deford fine sand, 1,320 feet west and 1,270 feet south of the northeast corner of sec. 2, T. 39 N., R. 28 W.

A—0 to 6 inches; black (10YR 2/1) fine sand, very dark gray (10YR 3/1) dry; single grain; loose; slightly acid; abrupt wavy boundary.
Cg—6 to 12 inches; grayish brown (10YR 5/2) loamy fine sand; few fine prominent strong brown (7.5YR 4/6) mottles; single grain; loose; neutral; gradual wavy boundary.
C—12 to 60 inches; brown (10YR 5/3) fine sand; single grain; loose; neutral.

Free carbonates commonly are in the lower part of the profile. Some pedons have a thin Oa horizon. The A horizon has hue of 5YR, 7.5YR, or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is fine sand, loamy fine sand, or mucky fine sand. The C horizon has hue of 2.5Y or 10YR, value of 5 to 7, and chroma of 1 to 4. It is fine sand, loamy fine sand, or very fine sand that has thin layers of sand, loamy sand, or silt.

Emmet Series

The Emmet series consists of well drained, moderately permeable soils on moraines, till plains, and drumlins. These soils formed in calcareous, loamy glacial till. Slopes range from 0 to 35 percent.

Emmet soils are similar to Pemene and Oconto soils and are commonly adjacent to Carbondale, Cathro, and Pemene soils. Pemene soils are coarser textured than the Emmet soils. Oconto soils have a gravelly sand substratum. Carbondale and Cathro soils are very poorly drained and are lower on the landscape than the Emmet soils.

Typical pedon of Emmet fine sandy loam, 0 to 6 percent slopes, 1,180 feet east and 20 feet south of the northwest corner of sec. 1, T. 39 N., R. 28 W.

A—0 to 2 inches; black (10YR 2/1) loam, dark reddish brown (5YR 2/2) dry; weak fine granular structure; friable; about 1 percent pebbles and cobbles; medium acid; abrupt wavy boundary.
E—2 to 4 inches; dark brown (7.5YR 4/2) fine sandy loam; weak very fine subangular blocky structure; friable; about 2 percent pebbles and cobbles; slightly acid; abrupt broken boundary.
Bs—4 to 13 inches; dark brown (7.5YR 4/4) fine sandy loam; weak fine subangular blocky structure; friable; about 1 percent pebbles and cobbles; neutral; abrupt wavy boundary.
E'—13 to 16 inches; reddish brown (5YR 5/3) sandy loam; weak fine subangular blocky structure; friable; about 2 percent pebbles and cobbles; neutral; abrupt broken boundary.
Bt—16 to 22 inches; reddish brown (5YR 4/4) fine sandy loam; moderate medium subangular blocky structure; friable; dark reddish brown (5YR 3/4) clay films of faces of peds; about 5 percent pebbles and cobbles; neutral; clear irregular boundary.
BC—22 to 33 inches; reddish brown (5YR 4/4) fine sandy loam; weak medium subangular blocky structure; friable; about 13 percent pebbles and cobbles; mildly alkaline; clear wavy boundary.
C—33 to 60 inches; reddish brown (5YR 5/4) gravelly fine sandy loam; massive; firm; about 17 percent pebbles and cobbles; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates are 24 to 50 inches. The content of pebbles is 2 to 15 percent in the solum and 5 to 25 percent in the C horizon. The content of cobbles is 0 to 20 percent in the A and E horizons and 0 to 5 percent in the lower horizons.

Some pedons have a thin Oe horizon. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam or loam. The E horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5, and chroma of 1 to 3. Pedons in cultivated areas have an Ap horizon. This horizon is 6 to 10 inches thick. It has hue or 7.5YR or 10YR, value of 3 or 4, and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. The E' horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. It is sandy loam, fine sandy loam, or loamy sand. Some pedons have an E/B horizon, a B/E horizon, or both. The Bt horizon has hue of 5YR or 7.5YR, value of 4, and chroma of 3 or 4. It is sandy loam, fine sandy loam, or loam. The C horizon is dominantly sandy loam, gravelly sandy loam, gravelly fine sandy loam, or fine sandy loam. In some pedons, however, it has thin layers of sand, gravelly sand, or loamy sand.

Ensley Series

The Ensley series consists of poorly drained soils on till plains and moraines. These soils formed in loamy glacial till. Permeability is moderate in the upper part of the profile and moderately rapid in the lower part. Slopes are 0 to 1 percent.

Ensley soils are similar to Solona soils and are commonly adjacent to Carbondale, Cathro, Emmet, Pemene, and Solona soils. The organic Carbondale and Cathro soils are very poorly drained and are generally slightly lower on the landscape than the Ensley soils. Emmet, Pemene, and Solona soils are higher on the landscape than the Ensley soils. Emmet and Pemene soils are well drained, and Solona soils are somewhat poorly drained.

Typical pedon of Ensley fine sandy loam, 2,350 feet south and 2,620 feet west of the northeast corner of sec. 20, T. 43 N., R. 29 W.

A—0 to 3 inches; black (7.5YR 2/0) fine sandy loam, very dark gray (N 3/0) dry; moderate medium granular structure; friable; about 3 percent pebbles and cobbles; neutral; abrupt smooth boundary.

EB—3 to 9 inches; dark grayish brown (10YR 4/2) fine sandy loam; many coarse prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; about 5 percent pebbles and cobbles; neutral; clear wavy boundary.

Bw—9 to 20 inches; dark yellowish brown (10YR 4/4) fine sandy loam; many medium distinct reddish yellow (7.5YR 6/6) mottles; moderate medium subangular blocky structure; friable; about 8 percent pebbles and cobbles; neutral; clear wavy boundary.

C1—20 to 30 inches; yellowish brown (10YR 5/4) fine sandy loam; common medium distinct reddish yellow (7.5YR 6/6) mottles; massive; friable; about 7 percent pebbles and cobbles; neutral; gradual wavy boundary.

C2—30 to 46 inches; brown (7.5YR 5/4) fine sandy loam; massive; friable; about 9 percent pebbles and cobbles; mildly alkaline; clear wavy boundary.

C3—46 to 60 inches; strong brown (7.5YR 4/6) fine sandy loam; massive; friable; about 10 percent pebbles and cobbles; mildly alkaline.

The solum is 15 to 40 inches thick. The content of pebbles and cobbles is 2 to 15 percent throughout the profile.

Some pedons have a thin Oa horizon. The A horizon has hue of 7.5YR or 10YR or is neutral in hue. It has value of 1 or 2 and chroma of 0 to 2. It is fine sandy loam or mucky fine sandy loam. The EB horizon has hue of 10YR or 2.5Y and value of 2 to 6. The Bw horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 6, and chroma or 2 to 4. It is sandy loam or fine sandy loam. The C horizon is dominantly sandy loam or fine sandy loam, but in some pedons it has thin layers of loamy sand or sand. It has free carbonates in some pedons.

Escanaba Series

The Escanaba series consists of well drained soils on moraines and till plains. These soils formed in sandy glacial drift over loamy glacial till. Permeability is moderately rapid in the sandy upper horizons and moderate in the underlying loamy horizons. Slopes range from 0 to 18 percent.

Escanaba soils are commonly adjacent to Emmet, Pemene, and Zimmerman soils. Emmet and Pemene soils do not have a sandy mantle. They are typically higher on the landscape than the Escanaba soils. Zimmerman soils are coarser textured in the substratum than the Escanaba soils. They are in landscape positions similar to those of the Escanaba soils.

Typical pedon of Escanaba loamy fine sand, 6 to 18 percent slopes, 1,030 feet north and 80 feet west of the center of sec. 20, T. 44 N., R. 27 W.

Oe—1 inch to 0; partially decomposed hardwood leaf litter; abrupt smooth boundary.

A—0 to 2 inches; black (5YR 2/1) loamy fine sand, very dark gray (5YR 3/1) dry; weak fine granular structure; very friable; about 1 percent pebbles and cobbles; neutral; abrupt wavy boundary.

E—2 to 6 inches; reddish gray (5YR 5/2) loamy fine sand; weak medium subangular blocky structure; very friable; about 1 percent pebbles and cobbles; slightly acid; abrupt wavy boundary.

Bs1—6 to 9 inches; dark reddish brown (5YR 3/4) loamy fine sand; weak medium subangular blocky structure; very friable; about 1 percent pebbles and cobbles; slightly acid; abrupt irregular boundary.

Bs2—9 to 21 inches; reddish brown (5YR 4/4) loamy fine sand; weak medium subangular blocky

structure; very friable; about 4 percent pebbles and cobbles; neutral; gradual wavy boundary.

2E/B—21 to 34 inches; reddish brown (5YR 4/3) loamy fine sand (E); about 40 percent dark reddish brown (5YR 3/4) fine sandy loam (Bt); weak medium subangular blocky structure; very friable; about 4 percent pebbles and cobbles; neutral; clear irregular boundary.

2Bt—34 to 46 inches; dark reddish brown (5YR 3/4) fine sandy loam; weak medium subangular blocky structure; friable; dark reddish brown (5YR 3/3) clay films on faces of peds; about 4 percent pebbles and cobbles; neutral; gradual wavy boundary.

2C—46 to 60 inches; reddish brown (5YR 4/4) fine sandy loam; massive; friable; about 9 percent pebbles and cobbles; neutral.

The solum is 30 to 50 inches thick. The sandy mantle is 20 to 40 inches thick. The content of pebbles is 0 to 8 percent in the solum and 3 to 15 percent in the 2C horizon. The content of cobbles is 0 to 5 percent throughout the profile.

The A and E horizons are loamy fine sand or fine sand. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 5YR or 7.5YR, value or 3 to 5, and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value or 3 to 5, and chroma of 3 to 6. It is loamy fine sand, fine sand, loamy sand, or sand. The E part of the 2E/B horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 2 or 3. It is loamy sand or loamy fine sand. The B part of the 2E/B horizon and the 2Bt horizon have hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. They are fine sandy loam or sandy loam. The 2C horizon is fine sandy loam, sandy loam, or gravelly sandy loam.

Fence Series

The Fence series consists of well drained, moderately slowly permeable soils in glacial lake basins and on stream terraces. These soils formed in silty and loamy lacustrine deposits. Slopes range from 0 to 18 percent.

Fence soils are commonly adjacent to Mancelona, Pemene, and Rubicon soils. The adjacent soils are generally higher on the landscape than the Fence soils. Also, Mancelona and Rubicon soils are coarser textured. Pemene soils formed in glacial till.

Typical pedon of Fence very fine sandy loam, 0 to 6 percent slopes, 2,465 feet north and 1,320 feet west of the southeast corner of sec. 23, T. 39 N., R. 29 W.

A—0 to 6 inches; black (5YR 2/1) very fine sandy loam, gray (5YR 5/1) dry; moderate medium granular structure; friable; medium acid; abrupt wavy boundary.

E—6 to 8 inches; brown (7.5YR 5/2) very fine sandy loam; weak fine subangular blocky structure; friable; medium acid; clear broken boundary.

Bs—8 to 15 inches; dark brown (7.5YR 4/4) very fine sandy loam; weak fine subangular blocky structure; friable; medium acid; clear wavy boundary.

E'—15 to 38 inches; brown (7.5YR 5/4) silt loam; weak medium platy structure; friable; strongly acid; gradual wavy boundary.

E&Bt—38 to 48 inches; brown (7.5YR 5/4) loamy very fine sand (E); very weak medium subangular blocky structure; very friable; bands of yellowish red (5YR 4/6) very fine sandy loam (Bt) 1/8 inch to 3 inches thick; massive; friable; strongly acid; clear wavy boundary.

C—48 to 60 inches; brown (7.5YR 4/4) stratified loamy very fine sand and very fine sandy loam; massive; very friable; medium acid.

The solum is 28 to 49 inches thick. Some pedons have a thin Oe horizon. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2 or 3. Pedons in cultivated areas have an Ap horizon. This horizon is very fine sandy loam 6 to 12 inches thick. It has hue of 5YR or 7.5YR, value or 3 or 4, and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. The E' horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is very fine sandy loam or silt loam. The E part of the E&Bt horizon has colors similar to those of the E' horizon. It is loamy very fine sand or very fine sandy loam. The Bt part has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. In some pedons the C horizon has strata of fine sand or sand.

Greenwood Series

The Greenwood series consists of very poorly drained, organic soils in bogs. These soils formed in decomposed herbaceous plant remains. Permeability is moderate or moderately rapid. Slopes are 0 to 1 percent.

Greenwood soils are similar to Dawson soils and are commonly adjacent to Dawson, Pemene, Rubicon, and Wainola soils. Dawson soils are organic to a depth of less than 51 inches. Pemene, Rubicon, and Wainola soils are higher on the landscape than the Greenwood soils. Pemene soils are well drained, Rubicon soils are excessively drained, and Wainola soils are somewhat poorly drained.

Typical pedon of Greenwood peat, in an area of Greenwood and Dawson peats, 2,000 feet west and 350 feet north of the southeast corner of sec. 28, T. 44 N., R. 30 W.

Oi—0 to 6 inches; fibric material, dark brown (10YR 3/3) broken face, brown (10YR 5/3) rubbed; about 95

percent fiber, 75 percent rubbed; massive; friable; primarily sphagnum material; extremely acid; gradual wavy boundary.
Oe1—6 to 20 inches; hemic material, very dark grayish brown (10YR 3/2) broken face, brown (10YR 4/3) rubbed; about 80 percent fiber, 25 percent rubbed; weak coarse subangular blocky structure; friable; primarily herbaceous material; extremely acid; clear wavy boundary.
Oe2—20 to 42 inches; hemic material, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed; about 60 percent fiber, 20 percent rubbed; weak medium subangular blocky structure; friable; primarily herbaceous material; extremely acid; clear wavy boundary.
Oe3—42 to 60 inches; hemic material, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed; about 40 percent fiber, 20 percent rubbed; massive; friable; primarily herbaceous material; extremely acid.

The organic material is more than 51 inches thick. It has hue of 5YR, 7.5YR, or 10YR and value and chroma of 2 to 4. Some pedons have thin layers of sapric material.

Hettinger Series

The Hettinger series consists of poorly drained, slowly permeable soils in glacial drainage channels and lake basins. These soils formed in calcareous, silty lacustrine deposits. Slopes are 0 to 1 percent.

Hettinger soils are similar to Alstad soils and are commonly adjacent to Carbondale, Cathro, Emmet, and Pemene soils on the landscape. Alstad soils are somewhat poorly drained. The organic Carbondale and Cathro soils are very poorly drained and are generally slightly lower on the landscape than the Hettinger soils. Emmet and Pemene soils are well drained and are higher on the landscape than the Hettinger soils.

Typical pedon of Hettinger silt loam, 1,980 feet west and 660 feet south of the northeast corner of sec. 15, T. 40 N., R. 30 W.

A—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; neutral; abrupt wavy boundary.
Bg1—6 to 8 inches; dark gray (10YR 4/1) silty clay loam; moderate fine subangular blocky structure; firm; neutral; clear wavy boundary.
Bg2—8 to 14 inches; dark grayish brown (10YR 4/2) silty clay loam; common medium prominent strong brown (7.5YR 4/6) mottles; weak fine subangular blocky structure; firm; mildly alkaline; abrupt wavy boundary.
BC—14 to 26 inches; dark brown (7.5YR 4/2) silt loam; few fine faint brown (7.5YR 5/2) mottles; weak fine subangular blocky structure; firm; slight effervescence; mildly alkaline; abrupt smooth boundary.
Cg—26 to 60 inches; brown (7.5YR 5/2) stratified silty clay loam and silt loam that has thin layers of red (2.5YR 4/6) clay loam; common fine prominent greenish gray (5G 6/1) and common medium distinct yellowish brown (10YR 5/4) mottles; massive; firm; slight effervescence; moderately alkaline.

The solum is 18 to 36 inches thick. The depth to free carbonates is 12 to 36 inches.

Some pedons have a thin Oa horizon. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silt loam or loam. The Bg horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is typically silty clay loam, but in some pedons it has strata of silt loam.

Karlin Series

The Karlin series consists of somewhat excessively drained soils on outwash plains. These soils formed in glacial outwash. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 35 percent.

Karlin soils are similar to Vilas soils and are commonly adjacent to Emmet and Pemene soils. Vilas soils are dominantly medium sand in the solum. Emmet and Pemene soils formed in loamy glacial till. They are generally higher on the landscape than the Karlin soils.

Typical pedon of Karlin loamy fine sand, 0 to 6 percent slopes, 1,900 feet east and 650 feet north of the southwest corner of sec. 26, T. 42 N., R. 30 W.

A—0 to 2 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; strongly acid; abrupt wavy boundary.
E—2 to 4 inches; pinkish gray (5YR 6/2) loamy fine sand; weak medium subangular blocky structure; very friable; very strongly acid; clear wavy boundary.
Bs1—4 to 7 inches; yellowish red (5YR 4/6) loamy fine sand; weak medium subangular blocky structure; friable; strongly acid; clear wavy boundary.
Bs2—7 to 19 inches; strong brown (7.5YR 4/6) loamy fine sand; weak medium subangular blocky structure; very friable; strongly acid; clear wavy boundary.
Bs3—19 to 23 inches; brown (7.5YR 5/4) loamy fine sand; weak medium subangular blocky structure; very friable; medium acid; abrupt wavy boundary.
BC—23 to 31 inches; strong brown (7.5YR 4/6) loamy sand; weak medium subangular blocky structure; very friable; medium acid; clear wavy boundary.
C—31 to 60 inches; brown (7.5YR 5/4) sand; single grain; loose; several strong brown (7.5YR 4/6) lamellae of loamy sand about 1/8 inch thick

between depths of 45 and 60 inches; about 3 percent pebbles; medium acid.

The solum is 20 to 40 inches thick. The content of pebbles is 0 to 5 percent throughout the profile. Some pedons have a thin Oe horizon. The A and E horizons are loamy fine sand or fine sandy loam. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6, and chroma of 1 or 2. The Bs horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6.

Kinross Series

The Kinross series consists of poorly drained, rapidly permeable soils on outwash plains. These soils formed in sandy glacial outwash. Slopes are 0 to 1 percent.

Kinross soils are similar to Deford soils and are commonly adjacent to Dawson, Greenwood, Rousseau, and Wainola soils. Deford soils do not have a spodic horizon and are less acid than the Kinross soils. The organic Dawson and Greenwood soils are very poorly drained and are generally slightly lower on the landscape than the Kinross soils. Rousseau and Wainola soils are higher on the landscape than the Kinross soils. Rousseau soils are moderately well drained or well drained, and Wainola soils are somewhat poorly drained.

Typical pedon of Kinross mucky fine sand, 2,420 feet north and 440 feet west of the southeast corner of sec. 10, T. 43 N., R. 30 W.

A—0 to 3 inches; black (N 2/0) mucky fine sand, very dark gray (10YR 3/1) dry; weak medium granular structure; friable; extremely acid; abrupt wavy boundary.

E—3 to 9 inches; brown (7.5YR 5/2) fine sand; common fine faint pinkish gray (7.5YR 6/2) mottles; weak fine subangular blocky structure; very friable; very strongly acid; abrupt wavy boundary.

Bhs—9 to 20 inches; dark reddish brown (5YR 3/3) fine sand; common medium faint dark reddish brown (5YR 2/2) mottles; weak medium subangular blocky structure; very friable; very strongly acid; abrupt wavy boundary.

BC—20 to 36 inches; strong brown (7.5YR 4/6) fine sand; few medium faint brown (7.5YR 4/4) mottles; single grain; loose; strongly acid; gradual wavy boundary.

C—36 to 60 inches; brown (7.5YR 5/4) fine sand; single grain; loose; medium acid.

The solum is 28 to 50 inches thick. Some pedons have a thin Oa horizon. The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is mucky fine sand, fine sand, or mucky loamy fine sand. The E horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 1 or 2. It is fine sand or sand. The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The BC horizon has hue of 5YR or 7.5YR and value and chroma of 4 to 6. The BC and C horizons are fine sand or sand.

Longrie Series

The Longrie series consists of well drained, moderately rapidly permeable or moderately permeable soils on bedrock-controlled topography. These soils formed in loamy glacial drift overlying limestone bedrock. Slopes range from 0 to 18 percent.

Longrie soils are commonly adjacent to Carbondale, Cathro, Emmet, Ensley, and Pemene soils. Carbondale, Cathro, and Ensley soils are lower on the landscape than the Longrie soils. Carbondale and Cathro soils are very poorly drained, and Ensley soils are poorly drained. Emmet and Pemene soils do not have bedrock within 60 inches of the surface. They are in landscape positions similar to those of the Longrie soils.

Typical pedon of Longrie fine sandy loam, 0 to 6 percent slopes, 1,100 feet north and 1,900 feet east of the southwest corner of sec. 29. T. 43 N., R. 28 W.

Oe—1 inch to 0; partially decomposed hardwood leaf litter; abrupt smooth boundary.

E—0 to 5 inches; brown (10YR 4/3) fine sandy loam; weak medium subangular blocky structure; friable; about 2 percent pebbles and cobbles; medium acid; abrupt wavy boundary.

Bs—5 to 20 inches; brown (7.5YR 4/4) fine sandy loam; moderate medium subangular blocky structure; friable; about 5 percent pebbles and cobbles; slightly acid; abrupt irregular boundary.

Bt—20 to 21 inches; dark brown (7.5YR 3/3) fine sandy loam; moderate medium subangular blocky structure; friable; about 8 percent pebbles and cobbles; neutral; abrupt broken boundary.

2R—21 inches; limestone bedrock.

The thickness of the solum and the depth to bedrock are 20 to 40 inches. The content of pebbles and cobbles is 2 to 10 percent in the solum.

Some pedons have an A horizon. This horizon is fine sandy loam. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4.

Mancelona Series

The Mancelona series consists of somewhat excessively drained soils on outwash plains. These soils formed in calcareous, sandy glacial outwash. Permeability is moderately rapid in the upper part of the

profile and very rapid in the lower part. Slopes range from 0 to 35 percent.

Mancelona soils are commonly adjacent to Emmet, Pemene, and Rubicon soils. Emmet and Pemene soils are finer textured than the Mancelona soils. Also, they are generally higher on the landscape. Rubicon soils have a sand substratum. They are in landscape positions similar to those of the Mancelona soils.

Typical pedon of Mancelona loamy sand, 0 to 6 percent slopes, 1,530 feet west and 920 feet south of the northeast corner of sec. 28, T. 44 N., R. 29 W.

Oe—1 inch to 0; partially decomposed conifer and hardwood leaf litter and sedges; abrupt smooth boundary.
A—0 to 1 inch; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; about 1 percent pebbles and cobbles; strongly acid; abrupt wavy boundary.
E—1 to 3 inches; brown (7.5YR 5/2) loamy sand; single grain; loose; about 1 percent pebbles and cobbles; strongly acid; abrupt wavy boundary.
Bs1—3 to 9 inches; strong brown (7.5YR 4/6) loamy sand; weak medium subangular blocky structure; very friable; about 4 percent pebbles and cobbles; medium acid; clear smooth boundary.
Bs2—9 to 17 inches; strong brown (7.5YR 5/6) loamy sand; single grain; loose; about 8 percent pebbles and cobbles; medium acid; clear wavy boundary.
Bs3—17 to 26 inches; strong brown (7.5YR 5/6) sand; single grain; loose; about 7 percent pebbles and cobbles; medium acid; abrupt wavy boundary.
2Bt—26 to 31 inches; dark brown (7.5YR 4/4) gravelly loamy sand; weak medium subangular blocky structure; friable; thin discontinuous clay films on faces of peds; about 25 percent pebbles and cobbles; neutral; abrupt wavy boundary.
2C—31 to 60 inches; strong brown (7.5YR 5/6) very gravelly coarse sand; single grain; loose; about 50 percent pebbles and cobbles, decreasing to 25 percent at a depth of about 60 inches; slight effervescence; moderately alkaline.

The solum is 18 to 40 inches thick. The coarse fragments are primarily pebbles. The content of pebbles and cobbles is 5 to 35 percent in the solum and 15 to 55 percent in the 2C horizon.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2 to 4. The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. The A, E, and Bs horizons are loamy sand, sand, gravelly loamy sand, or gravelly sand. The 2Bt horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is gravelly sandy loam or gravelly loamy sand. The 2C horizon is dominantly very gravelly coarse sand, very gravelly sand, or gravelly sand. In some pedons, however, it has thin layers of coarse sand.

Nadeau Series

The Nadeau series consists of well drained soils on outwash plains, eskers, and stream terraces. These soils formed in loamy glacial drift over calcareous, sandy glacial outwash. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 35 percent.

Nadeau soils are commonly adjacent to Emmet, Mancelona, and Pemene soils. The adjacent soils are in landscape positions similar to those of the Nadeau soils. Emmet and Pemene soils do not have a gravelly subsoil and do not have gravelly sand in the substratum. Mancelona soils are coarser textured in the upper part than the Nadeau soils.

Typical pedon of Nadeau fine sandy loam, 6 to 18 percent slopes, 1,760 feet west and 880 feet north of the southeast corner of sec. 36, T. 39 N., R. 28 W.

A—0 to 4 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; about 5 percent pebbles and cobbles; medium acid; abrupt wavy boundary.
E—4 to 13 inches; brown (7.5YR 4/2) fine sandy loam; moderate fine subangular blocky structure; friable; about 8 percent pebbles and cobbles; slightly acid; abrupt wavy boundary.
Bt1—13 to 25 inches; dark brown (7.5YR 4/4) fine sandy loam; moderate medium subangular blocky structure; friable; about 8 percent pebbles and cobbles; slightly acid; clear wavy boundary.
2Bt2—25 to 30 inches; brown (7.5YR 4/4) very gravelly loam; moderate medium subangular blocky structure; friable; thin continuous clay films on faces of peds and pebbles; about 40 percent pebbles and cobbles; mildly alkaline; gradual wavy boundary.
2BC—30 to 38 inches; brown (7.5YR 4/4) very gravelly sand; single grain; loose; about 50 percent pebbles and cobbles; mildly alkaline; slight effervescence; abrupt wavy boundary.
2C—38 to 60 inches; brown (7.5YR 4/4) very gravelly sand; single grain; loose; about 60 percent pebbles and cobbles; moderately alkaline; slight effervescence.

The solum is 18 to 40 inches thick. The coarse fragments are primarily pebbles. The content of pebbles and cobbles is 2 to 15 percent in the A, E, and Bt1 horizons and 35 to 60 percent in the 2Bt, 2BC, and 2C horizons.

Some pedons have a thin Oe horizon. The A, E, and Bt1 horizons are fine sandy loam or gravelly fine sandy loam. The A horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 to 4 and chroma of 0 to

3. The E horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2 or 3. The Bt1 horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4. The 2Bt horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is very gravelly loam or very gravelly sand loam.

Oconto Series

The Oconto series consists of well drained soils on outwash plains. These soils formed in loamy glacial drift over sandy glacial outwash. Permeability is moderate in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 0 to 18 percent.

Oconto soils are similar to Emmet and Pemene soils and are commonly adjacent to Emmet, Pemene, Pence, and Vilas soils. Emmet and Pemene soils do not have gravelly sand in the substratum. Pence and Vilas soils are in landscape positions similar to those of the Oconto soils. Pence soils are shallower to sandy material than the Oconto soils. Vilas soils are coarser textured than the Oconto soils.

Typical pedon of Oconto fine sandy loam, 0 to 6 percent slopes, 2,000 feet south and 1,000 feet east of the northwest corner of sec. 20, T. 40 N., R. 29 W.

Oe—2 inches to 0; partially decomposed hardwood leaf litter; abrupt smooth boundary.
E—0 to 3 inches; dark brown (7.5YR 4/2) fine sandy loam; weak fine subangular blocky structure; friable; about 2 percent pebbles; medium acid; abrupt wavy boundary.
Bs1—3 to 15 inches; dark brown (7.5YR 4/4) very fine sandy loam; weak fine subangular blocky structure; friable; about 2 percent pebbles; medium acid; clear wavy boundary.
Bs2—15 to 18 inches; strong brown (7.5YR 4/6) fine sandy loam; weak medium subangular blocky structure; friable; about 2 percent pebbles; medium acid; abrupt wavy boundary.
B/E—18 to 27 inches; reddish brown (5YR 4/4) loam (Bt); about 10 percent brown (7.5YR 4/2) sandy loam (E); moderate medium subangular blocky structure; friable; clay films on faces of peds; about 5 percent pebbles; medium acid; abrupt wavy boundary.
2BC—27 to 38 inches; dark brown (7.5YR 4/4) loamy sand; very weak medium subangular blocky structure; very friable; about 5 percent pebbles and cobbles; slightly acid; abrupt wavy boundary.
2C—38 to 60 inches; light yellowish brown (10YR 6/4) gravelly sand; single grain; loose; about 30 percent pebbles and cobbles; slight effervescence; moderately alkaline.

The solum is 24 to 40 inches thick. The coarse fragments are primarily pebbles. The content of pebbles and cobbles is 0 to 5 percent in the upper part of the solum, 4 to 15 percent in the lower part, and 15 to 35 percent in the 2C horizon.

Some pedons have an A horizon. This horizon is fine sandy loam 1 to 3 inches thick. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has value of 4 or 5 and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The Bt part of the the B/E horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. The E part has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2 or 3.

Pemene Series

The Pemene series consist of well drained soils on kames, moraines, kettles, and till plains. These soils formed in loamy, ice-contact glacial drift. Permeability is moderate or moderately rapid. Slopes range from 0 to 35 percent.

These soils have slightly higher base saturation than is definitive for the Pemene series. This difference, however, does not alter the usefulness or behavior of the soils.

Pemene soils are similar to Emmet and Oconto soils and are commonly adjacent to Carbondale, Cathro, Emmet, and Zimmerman soils. Emmet soils are finer textured than the Pemene soils. Oconto soils have gravelly sand in the substratum. Carbondale and Cathro soils are very poorly drained and are lower on the landscape than the Pemene soils. Zimmerman soils are coarser textured than the Pemene soils. Also, they generally are lower on the landscape.

Typical pedon of Pemene fine sandy loam, 0 to 6 percent slopes, 2,500 feet south and 300 feet east of the northwest corner of sec. 5, T. 44 N., R. 29 W.

A—0 to 1 inch; black (5YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; about 1 percent pebbles and cobbles; very strongly acid; abrupt wavy boundary.
E—1 to 3 inches; pinkish gray (7.5YR 6/2) fine sandy loam; weak fine subangular blocky structure; very friable; about 2 percent pebbles and cobbles; strongly acid; abrupt wavy boundary.
Bs—3 to 15 inches; strong brown (7.5YR 4/6) fine sandy loam; weak fine subangular blocky structure; very friable; about 6 percent pebbles and cobbles; medium acid; clear wavy boundary.
E/B—15 to 27 inches; brown (7.5YR 5/4) loamy fine sand (E); about 15 percent reddish brown (5YR 4/4) fine sandy loam (Bt) in the upper part to 45 percent in the lower part; weak medium subangular blocky structure; very friable (E) and friable (B); few clay films on faces of peds; about 6 percent pebbles and cobbles; medium acid; clear irregular boundary.
B/E—27 to 48 inches; reddish brown (5YR 4/4) fine sandy loam (Bt); about 25 percent brown (7.5YR

5/4) loamy fine sand (E); weak medium subangular blocky structure; friable (B) and very friable (E); many clay films of faces of peds; about 7 percent pebbles and cobbles; neutral; clear irregular boundary.

E&Bt—48 to 60 inches; yellowish red (5YR 5/6) loamy fine sand (E); bands of reddish brown (5YR 4/4) fine sandy loam (Bt) 1/16 to 1/8 inch thick; massive; very friable; about 5 percent pebbles and cobbles; mildly alkaline.

The solum is 30 to more than 60 inches thick. The content of pebbles and cobbles is 1 to 10 percent in the upper part of the solum and 5 to 25 percent in the lower part and in the C horizon.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2 or 3. Pedons in cultivated areas have an Ap horizon. This horizon is 6 to 10 inches thick. It has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 2 to 4. The Bs horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. The A, E, and Bs horizons are fine sandy loam or loamy fine sand. The E part of the E/B and B/E horizons has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is loamy fine sand or loamy sand. The B part has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is fine sandy loam or sandy loam. The E part of the E&Bt horizon is loamy fine sand, gravelly loamy fine sand, loamy sand, or gravelly loamy sand. Some pedons have a C horizon. This horizon is dominantly loamy fine sand, gravelly loamy fine sand, loamy sand, gravelly loamy sand, fine sandy loam, or gravelly fine sandy loam. In some pedons, however, it has thin layers of sand or gravelly sand. Some pedons have free carbonates.

Pence Series

The Pence series consists of well drained soils on outwash plains. These soils formed in loamy glacial drift over sandy glacial outwash. Permeability is moderately rapid in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 0 to 35 percent.

Pence soils are commonly adjacent to Oconto and Vilas soils. The adjacent soils are in landscape positions similar to those of the Pence soils. Oconto soils are loamy to a greater depth than the Pence soils. Vilas soils are coarser textured than the Pence soils.

Typical pedon of Pence fine sandy loam, 0 to 6 percent slopes, 352 feet north and 968 feet west of the center of sec. 2, T. 39 N., R. 31 W.

A—0 to 4 inches; dark reddish brown (5YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; slightly acid; abrupt wavy boundary.

Bs1—4 to 13 inches; reddish brown (5YR 4/4) fine sandy loam; weak medium subangular blocky structure; friable; strongly acid; clear wavy boundary.

Bs2—13 to 16 inches; yellowish red (5YR 4/6) sandy loam; weak fine subangular blocky structure; very friable; very strongly acid; clear wavy boundary.

Bs3—16 to 21 inches; yellowish red (5YR 4/6) loamy sand; single grain; loose; very strongly acid; clear wavy boundary.

2BC—21 to 27 inches; yellowish red (5YR 4/6) gravelly loamy sand; single grain; loose; about 20 percent pebbles; medium acid; clear wavy boundary.

2C1—27 to 40 inches; dark brown (7.5YR 4/4) sand; single grain; loose; about 8 percent pebbles; slightly acid; clear wavy boundary.

2C2—40 to 60 inches; brown (7.5YR 5/4) gravelly sand; single grain; loose; about 20 percent pebbles; slightly acid.

The solum is 18 to 36 inches thick. The coarse fragments are primarily pebbles. The content of pebbles and cobbles is 0 to 15 percent in the A and Bs horizons and 15 to 30 percent in the 2BC and 2C horizons.

Some pedons have a thin Oe horizon. The A horizon has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. Pedons in cultivated areas have an Ap horizon. This horizon is 6 to 10 inches thick. It has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. Some pedons have an E horizon. This horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2. The Bs horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 3 to 6.

Rousseau Series

The Rousseau series consists of well drained or moderately well drained, rapidly permeable soils on outwash plains and dunes. These soils formed in sandy glacial outwash and eolian deposits. Slopes range from 0 to 35 percent.

Rousseau soils are similar to Rubicon soils and are commonly adjacent to Cathro, Deford, Wainola, and Zimmerman soils. Rubicon soils are dominantly sand throughout. Cathro, Deford, and Wainola soils are lower on the landscape than the Rousseau soils. Cathro soils are very poorly drained, Deford soils are poorly drained, and Wainola soils are somewhat poorly drained. Zimmerman soils are finer textured than the Rousseau soils. Also, they are generally higher on the landscape.

Typical pedon of Rousseau fine sand, 18 to 35 percent slopes, 2,000 feet west and 1,300 feet north of the southeast corner of sec. 12, T. 43 N., R. 30 W.

Oe—1 inch to 0; black (N 2/0) partially decomposed hardwood and conifer leaf litter; abrupt wavy boundary.

E—0 to 6 inches; light brownish gray (10YR 6/2) fine sand; weak fine subangular blocky structure; very friable; very strongly acid; clear wavy boundary.
Bs1—6 to 11 inches; dark brown (7.5YR 4/4) fine sand; weak fine subangular blocky structure; very friable; strongly acid; clear wavy boundary.
Bs2—11 to 25 inches; brown (7.5YR 5/4) fine sand; single grain; loose; strongly acid; clear wavy boundary.
BC—25 to 31 inches; brown (7.5YR 4/4) fine sand; single grain; loose; strongly acid; clear wavy boundary.
C—31 to 60 inches; light brown (7.5YR 6/4) fine sand; single grain; loose; strongly acid.

The solum is 20 to 32 inches thick. It has thin layers of loamy fine sand or sand in some pedons.

Some pedons have an A horizon. This horizon is fine sand. It has hue of 5YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The E horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 1 or 2. The Bs horizon has hue of 5YR or 7.5YR and value and chroma of 3 to 6. The C horizon is fine sand or sand. Some pedons have mottles below a depth of 30 inches.

Rubicon Series

The Rubicon series consists of excessively drained, rapidly permeable soils on outwash plains. These soils formed in sandy glacial outwash. Slopes range from 0 to 35 percent.

Rubicon soils are similar to Rousseau soils and are commonly adjacent to Cathro, Deford, Mancelona, and Wainola soils. Rousseau soils are dominantly fine sand throughout. Cathro, Deford, and Wainola soils are lower on the landscape than the Rubicon soils. Cathro soils are very poorly drained, Deford soils are poorly drained, and Wainola soils are somewhat poorly drained. Mancelona soils have a gravelly sand substratum. They are in landscape positions similar to those of the Rubicon soils.

Typical pedon of Rubicon sand, 0 to 6 percent slopes, 900 feet west and 200 feet north of the southeast corner of sec. 29, T. 44 N., R. 29 W.

Oe—1 inch to 0; partially decomposed conifer leaf litter; abrupt smooth boundary.
A—0 to 2 inches; dark reddish brown (5YR 2/2) sand, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; very friable; about 1 percent pebbles; very strongly acid; abrupt smooth boundary.
E—2 to 5 inches; pinkish gray (5YR 6/2) sand; weak fine subangular blocky structure; very friable; about 1 percent pebbles; very strongly acid; abrupt wavy boundary.
Bs1—5 to 11 inches; dark brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; about 2 percent pebbles; medium acid; clear smooth boundary.
Bs2—11 to 21 inches; strong brown (7.5YR 4/6) sand; single grain; loose; about 3 percent pebbles; slightly acid; clear wavy boundary.
BC—21 to 41 inches; strong brown (7.5YR 5/8) sand; single grain; loose; about 1 percent pebbles; slightly acid; clear wavy boundary.
C—41 to 60 inches; strong brown (7.5YR 5/6) sand; single grain; loose; about 2 percent pebbles; slightly acid.

The solum is 25 to 50 inches thick. The content of pebbles is 0 to 5 percent throughout the profile.

The A horizon has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. It is sand or loamy sand. The E horizon has hue of 5YR or 7.5YR, value of 5 to 7, and chroma of 1 or 2. The Bs horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6.

Solona Series

The Solona series consists of somewhat poorly drained, moderately permeable soils on till plains and moraines. These soils formed in loamy glacial till. Slopes range from 0 to 4 percent.

Solona soils are similar to Channing and Ensley soils and are commonly adjacent to Cathro, Emmet, Ensley, and Pemene soils. Channing soils have gravelly sand in the substratum. The very poorly drained Cathro and poorly drained Ensley soils are lower on the landscape than the Solona soils. The well drained Emmet and Pemene soils are higher on the landscape than the Solona soils.

Typical pedon of Solona fine sandy loam, 0 to 4 percent slopes, 2,050 feet west and 650 feet north of the southeast corner of sec. 26, T. 40 N., R. 29 W.

A—0 to 5 inches; black (5YR 2/1) fine sandy loam, dark gray (5YR 4/1) dry; weak medium granular structure; friable; about 3 percent pebbles and cobbles; slightly acid; abrupt wavy boundary.
BE—5 to 10 inches; dark brown (7.5YR 4/4) fine sandy loam; weak fine subangular blocky structure; very friable; about 3 percent pebbles and cobbles; neutral; clear wavy boundary.
Bt—10 to 17 inches; dark brown (7.5YR 4/4) fine sandy loam; common fine faint strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; about 3 percent pebbles and cobbles; neutral; clear wavy boundary.
BC—17 to 23 inches; brown (7.5YR 5/4) fine sandy loam; common medium distinct dark brown (7.5YR 3/2) concretions (iron and manganese oxide); weak medium subangular blocky structure; friable; about 3

percent pebbles and cobbles; neutral; abrupt wavy boundary.

C1—23 to 46 inches; brown (7.5YR 5/4) fine sandy loam that has thin strata of sand and gravelly sand in the upper part; common fine distinct yellowish red (5YR 5/6) and few medium faint pinkish gray (7.5YR 6/2) mottles; massive; very friable; about 10 percent pebbles and cobbles; slight effervescence; mildly alkaline; abrupt wavy boundary.

C2—46 to 53 inches; reddish brown (5YR 5/3) very fine sandy loam; common medium distinct yellowish red (5YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline; abrupt wavy boundary.

C3—53 to 60 inches; reddish brown (5YR 5/3) stratified loamy very fine sand and very fine sandy loam; common coarse prominent yellowish red (5YR 4/8) mottles; single grain; loose; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to carbonates are 20 to 40 inches. The content of pebbles and cobbles is 1 to 15 percent in the solum and 0 to 25 percent in the C horizon.

Some pedons have a thin Oe horizon. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 1 or 2. The BE and Bt horizons have hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. They are fine sandy loam, loam, or sandy loam. The C horizon is dominantly fine sandy loam, sandy loam, gravelly sandy loam, gravelly fine sandy loam, very fine sandy loam, or loamy very fine sand. The last two textures are at a depth of 40 inches or more. In some pedons this horizon has water-sorted strata of sand or gravelly sand.

Ubly Variant

The Ubly Variant consists of well drained soils on moraines and till plains. These soils formed in loamy glacial till. Permeability is moderate in the solum and slow in the substratum. Slopes range from 2 to 18 percent.

Ubly Variant soils are commonly adjacent to Alstad, Carbondale, Cathro, and Emmet soils. Alstad, Carbondale, and Cathro soils are lower on the landscape than the Ubly Variant soils. Alstad soils are somewhat poorly drained, and Carbondale and Cathro soils are very poorly drained. Emmet soils have a substratum that is coarser textured than that of the Ubly Variant soils. They are in landscape positions similar to those of the Ubly Variant soils.

Typical pedon of Ubly Variant very fine sandy loam, 6 to 18 percent slopes, 2,500 feet north and 250 feet east of the southwest corner of sec. 26, T. 42 N., R. 28 W.

A—0 to 5 inches; black (10YR 2/1) very fine sandy loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; medium acid; abrupt wavy boundary.

E—5 to 7 inches; brown (10YR 4/3) very fine sandy loam; weak medium subangular blocky structure; very friable; medium acid; abrupt broken boundary.

Bs—7 to 19 inches; dark brown (7.5YR 3/4) very fine sandy loam; weak medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

E/B—19 to 23 inches; brown (7.5YR 5/2) very fine sandy loam (E); about 10 percent dark reddish brown (5YR 3/4) very fine sandy loam (B); massive; firm; about 3 percent pebbles; medium acid; abrupt irregular boundary.

2C—23 to 60 inches; dark reddish brown (2.5YR 3/4) clay loam; massive; very firm; about 6 percent pebbles and cobbles; slightly acid.

The solum is 15 to 35 inches thick. The content of pebbles is 0 to 5 percent in the solum. The content of pebbles and cobbles is 5 to 10 percent in the 2C horizon.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. It is fine sandy loam or very fine sandy loam. The E horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 or 3. It is loamy fine sand, loamy very fine sand, fine sandy loam, or very fine sandy loam. Pedons in cultivated areas have an Ap horizon. This horizon is 6 to 10 inches thick. It has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is fine sandy loam or very fine sandy loam. The E part of the E/B horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is fine sandy loam, very fine sandy loam, or loam. The B part has value of 3 to 5 and chroma of 3 to 6. Some pedons do not have an E/B horizon. The 2C horizon has hue of 10R or 2.5YR, value of 2 to 4, and chroma of 3 or 4.

Vilas Series

The Vilas series consists of excessively drained, rapidly permeable soils on outwash plains. These soils formed in sandy glacial outwash. Slopes range from 0 to 35 percent.

Vilas soils are similar to Karlin soils and are commonly adjacent to Oconto and Pence soils. Karlin soils are dominantly fine sand in the solum. Oconto and Pence soils are finer textured than the Vilas soils. They are in landscape positions similar to those of the Vilas soils.

Typical pedon of Vilas loamy sand, 0 to 6 percent slopes, 1,400 feet west and 90 feet north of the center of sec. 2, T. 39 N., R. 31 W.

A—0 to 3 inches; black (N 2/0) loamy sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; very strongly acid; abrupt wavy boundary.

Bs1—3 to 10 inches; dark brown (7.5YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; strongly acid; clear wavy boundary.
Bs2—10 to 17 inches; strong brown (7.5YR 5/6) loamy sand; single grain; loose; slightly acid; clear wavy boundary.
BC—17 to 34 inches; strong brown (7.5YR 5/6) sand; single grain; loose; slightly acid; clear wavy boundary.
C1—34 to 50 inches; brown (7.5YR 5/4) sand; single grain; loose; slightly acid; clear wavy boundary.
C2—50 to 60 inches; light brown (7.5YR 6/4) sand; single grain; loose; slightly acid.

The solum is 24 to 45 inches thick. The content of pebbles is 0 to 15 percent throughout the profile.

Some pedons have a thin Oe horizon. The A horizon has hue of 5YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. Some pedons have an E horizon. This horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2. The Bs horizon has hue of 5YR or 7.5YR and value and chroma of 3 to 6.

Wainola Series

The Wainola series consists of somewhat poorly drained, rapidly permeable soils on outwash plains. These soils formed in sandy glacial outwash. Slopes range from 0 to 3 percent.

Wainola soils are commonly adjacent to Deford, Kinross, Pemene, Rousseau, and Zimmerman soils. Deford and Kinross soils are poorly drained and are lower on the landscape than the Wainola soils. Pemene, Rousseau, and Zimmerman soils are higher on the landscape than the Wainola soils. Pemene soils are well drained, Rousseau soils are well drained or moderately well drained, and Zimmerman soils are excessively drained.

Typical pedon of Wainola fine sand, 0 to 3 percent slopes, 1,400 feet north and 2,300 feet west of the southeast corner of sec. 8, T. 44 N., R. 28 W.

A—0 to 2 inches; black (N 2/0) fine sand; weak medium granular structure; very friable; medium acid; abrupt smooth boundary.
E—2 to 4 inches; grayish brown (10YR 5/2) fine sand; weak very fine subangular blocky structure; very friable; medium acid; abrupt wavy boundary.
Bs1—4 to 7 inches; dark brown (7.5YR 4/4) loamy fine sand; common medium distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; medium acid; abrupt wavy boundary.
Bs2—7 to 13 inches; brown (7.5YR 5/4) loamy fine sand; common fine faint strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; very friable; medium acid; clear wavy boundary.
BC—13 to 37 inches; strong brown (7.5YR 5/6) fine sand; loose; single grain; medium acid; gradual wavy boundary.
C—37 to 60 inches; reddish yellow (7.5YR 6/6) fine sand; loose; single grain; slightly acid.

The solum is 18 to 42 inches thick. The content of pebbles is 0 to 5 percent throughout the profile.

Some pedons have a thin Oe horizon. The A and E horizons are fine sand or loamy fine sand. The A horizon has hue of 7.5YR or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The E horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. The Bs, BC, and C horizons are dominantly fine sand or loamy fine sand, but some pedons have thin layers of very fine sand or silt.

Waucedah Series

The Waucedah series consists of very poorly drained, moderately permeable soils on flood plains. These soils formed in loamy alluvium. Slopes are 0 to 1 percent.

Waucedah soils are similar to Cathro soils and are commonly adjacent to Carbondale, Cathro, Emmet, and Pemene soils. Cathro and Carbondale soils are organic to a depth of more than 15 inches. They are in landscape positions similar to those of the Waucedah soils but are generally farther from streams. Emmet and Pemene soils are well drained and are higher on the landscape than the Waucedah soils.

Typical pedon of Waucedah mucky sandy loam, in an area of Waucedah-Cathro complex, 2,000 feet east and 1,540 feet south of the northwest corner of sec. 34, T. 40 N., R. 29 W.

Oa—0 to 6 inches; sapric material, black (N 2/0) broken face and rubbed; about 30 percent fiber, less than 5 percent rubbed; weak medium granular structure; friable; herbaceous and woody material; about 20 percent mineral material; neutral; gradual wavy boundary.
A—6 to 11 inches; black (5YR 2/1) sandy loam; weak fine granular structure; friable; neutral; clear wavy boundary.
Cg1—11 to 36 inches; dark gray (10YR 4/1) loam that has thin layers of gray (10YR 5/1) sand; common medium prominent dark reddish brown (5YR 3/4) mottles; massive; friable; neutral; clear wavy boundary.
Cg2—36 to 60 inches; dark gray (10YR 4/1) loam that has thin layers of partially decomposed vegetation; massive; friable; slight effervescence; moderately alkaline.

The Oa horizon has hue of 5YR, 7.5YR, or 10YR or is neutral in hue. It has chroma of 0 to 2. The A horizon has hue of 5YR, 7.5YR, or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is sandy loam, fine sandy loam, or loam. The C horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 3 to 5 and chroma of 0 to 3. It is dominantly loam, fine sandy loam, or sandy loam. In some pedons, however, it has thin layers of gravelly sand, sand, fine sand, loamy sand, loamy fine sand, silt loam, or clay loam. In some pedons it does not have free carbonates.

Zimmerman Series

The Zimmerman series consists of excessively drained, rapidly permeable soils on outwash plains, kettles, kames, till plains, and moraines. These soils formed in sandy glacial drift. Slopes range from 0 to 35 percent.

Zimmerman soils are commonly adjacent to Emmet, Pemene, Rousseau, and Wainola soils. Emmet and Pemene soils are finer textured than the Zimmerman soils. Also, they are generally higher on the landscape. Rousseau and Wainola soils are generally lower on the landscape than the Zimmerman soils. Also, Rousseau soils are coarser textured in the substratum. Wainola soils are somewhat poorly drained.

Typical pedon of Zimmerman fine sand, 0 to 6 percent slopes, 1,500 feet west and 1,000 feet north of the center of sec. 18, T. 39 N., R. 29 W.

A—0 to 3 inches; black (5YR 2/1) fine sand, very dark gray (5YR 3/1) dry; weak fine granular structure; very friable; strongly acid; abrupt wavy boundary.

Bw1—3 to 18 inches; brown (7.5YR 4/4) fine sand; weak very fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.

Bw2—18 to 33 inches; reddish yellow (7.5YR 6/6) fine sand; single grain; loose; neutral; abrupt wavy boundary.

Bw3—33 to 45 inches; yellowish brown (10YR 5/6) fine sand; single grain; loose; neutral; clear wavy boundary.

E&Bt—45 to 60 inches; reddish yellow (7.5YR 6/6) fine sand (E); single grain; loose; bands of dark brown (7.5YR 4/4) loamy fine sand (Bt) 1/8 to 1 inch thick; massive; very friable; neutral.

The solum is more than 60 inches thick. Some pedons have a thin Oe horizon. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 1 or 2. Some pedons have an E horizon. This horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 or 3. The A and E horizons are loamy fine sand or fine sand. The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6, and chroma of 3 to 6. The E part of the E&Bt horizon has hue of 7.5YR or 10YR, value of 4 to 7, and chroma of 3 to 6. The Bt part has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is loamy fine sand, loamy very fine sand, or fine sandy loam. The combined thickness of the Bt bands is 0.5 inch to 6.0 inches.

Formation of the Soils

The paragraphs that follow relate the factors of soil formation to the soils in the survey area and explain the processes of soils formation.

Factors of Soil Formation

Soil forms through the interaction of five major factors—the physical, chemical, and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the processes of soil formation have acted on the parent material (*5*).

Climate and plant and animal life are the active forces of soil formation. They slowly change the parent material into a natural body of soils that have genetically related layers, called horizons. The effects of climate and plant and animal life are conditioned by relief. The nature of the parent material affects the kind of soil profile that forms. In extreme cases, it determines the soil profile almost entirely. Finally, time is needed for the differentiation of soil horizons. Generally, a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely related in their effects on the soils that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineralogical composition of the soil. The parent materials of the soils of Dickinson County were deposited by glaciers or meltwater from the glaciers. Some of these parent materials were reworked and redeposited by the subsequent actions of water and wind. Although most of the parent materials are of common glacial origin, their properties vary greatly, sometimes within small areas, depending on how the materials were deposited. The dominant parent materials in Dickinson County were deposited as glacial till, outwash, lacustrine material, eolian material, alluvium, and organic material.

Glacial till was deposited by glaciers with a minimum of water action. It is a mixture of particles of different sizes. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water.

The glacial till in Dickinson County is dominantly calcareous, although the content of carbonates varies considerably from area to area. The glacial till in the southeastern part of the county generally has a higher content of carbonates than that in the western part. The till is mainly fine sandy loam or loamy fine sand, but in a few areas it is clay loam or fine sand. Emmet and Pemene are examples of soils that formed in glacial till.

Outwash material was deposited by running water from melting glaciers. The size of the particles depends on the speed of the stream that carried the material. When the water slowed down, the coarser particles were deposited. Finer particles, such as very fine sand, silt, and clay, were carried by slowly moving water. Outwash deposits generally occur as layers of particles of similar size, such as sand, gravel, or other coarse particles. The edges of the pebbles and cobbles in these deposits are rounded. Pence and Mancelona are examples of soils that formed in outwash material.

Lacustrine material is deposited from still, or ponded, glacial meltwater. Because the coarser particles were deposited as outwash by moving glacial meltwater, only the finer particles, such as very fine sand, silt, and clay, remained to settle out in still water. The soils in Dickinson County that formed in lacustrine deposits are limited in extent. Hettinger soils are an example.

Eolian material in Dickinson County was redeposited by wind after initial deposition by glaciers or meltwater from the glaciers. These deposits are typically fine sand and are limited in extent. In some areas Rousseau soils formed in this material.

Alluvial material was recently deposited by floodwater along present streams. It varies in texture, depending on the speed of the water from which it was deposited. Waucedah soils formed in alluvial material.

Organic material occurs primarily as deposits of plant remains. After the glaciers melted, water remained standing in many shallow depressions. Other broad, nearly level areas were not covered with water but remained very wet because of a high water table. The plants growing in these areas, initially grasses, reeds, and sedges and then trees, died and fell to the ground or to the bottom of the shallow lakes and ponds. Because these areas were so wet, the plant remains decomposed only partially. Each year new plants grew

on top of the accumulated residue. After thousands of years, these organic deposits were several feet thick in some areas. Most of the shallow water areas that existed immediately after glaciation are now filled with these organic deposits. The process of accumulation continues today in most areas. Because of either artificial drainage or geologic deepening of natural drainageways, these areas eventually will become drier and the accumulation will stop. Cathro and Dawson are examples of soils that formed in organic material.

Plant and Animal Life

Plants have affected the soils in Dickinson County more significantly than the other living organisms. Bacteria, fungi, earthworms, and other small animals and the activities of some larger animals, however, also have been important. The chief contribution of plant and animal life is the addition of organic matter and nitrogen to the soil. The kind of organic material on and in the soil depends on the kinds of native plants that grew on the soil. The remains of these plants accumulated on the surface, decayed with the aid of fungi, and eventually became organic matter. The roots of the plants provided channels for the downward movement of air and water through the soil and added organic matter as they decayed. Bacteria in the soil helped to break down the organic matter into plant nutrients.

The vegetation that influenced soil formation in Dickinson County has varied somewhat, depending on changes in climate, but overall the native vegetation was probably similar to the current vegetation. Trees have been dominant. Differences in natural soil drainage and parent material have affected the composition of the forest species.

The well drained, loamy soils on uplands, such as Emmet and Fence soils, were covered mainly by northern hardwoods. Many of the sandy soils on uplands, such as Rubicon and Zimmerman soils, were covered dominantly by pine. The acid, organic Greenwood and Dawson soils were covered by sphagnum moss and acid-tolerant shrubs. The organic Carbondale and Cathro soils were covered by swamp conifers, such as northern white-cedar and black spruce. The wet, mineral soils, such as Ensley and Deford soils, were covered by a mixture of swamp conifers and lowland hardwoods.

Climate

Climate determines the kind of plant and animal life on and in the soil. It also determines the amount of water available for the weathering of minerals and for the translocation of soil material. Through its influence on soil temperatures, climate also determines the rate of chemical reaction in the soil.

The climate in Dickinson County is cool and humid. It is probably similar to that which prevailed during most of the time when the soils formed. The soils in Dickinson County differ from soils that formed under a dry, warm climate and from those that formed under a moist, hot climate. The climate is fairly uniform throughout the county. Only minor differences among the soils are the result of differences in climate.

Relief

Relief has markedly affected the soils of Dickinson County through its effect on natural drainage, runoff, erosion, plant cover, and soil temperature. Slopes range from 0 to 35 percent. Natural soil drainage ranges from excessively drained on sandy ridgetops to very poorly drained in depressions.

Through its effect on soil aeration, drainage influences the color of the soil. Runoff is most rapid on the steeper slopes. In some low areas, water is temporarily ponded. Water and air move freely through well drained soils and slowly through poorly drained soils. In soils that are well aerated, the iron and aluminum compounds that give most soils their color are oxidized and brightly colored. Poorly aerated soils are dull gray or mottled because the iron compounds are reduced. Emmet soils are an example of well drained, well aerated soils, and Ensley soils are an example of poorly drained, poorly aerated soils. Both of these soils formed in glacial till.

Time

Generally, a long time is needed for the development of distinct soil horizons. Differences in the length of time that the parent material has been in place are commonly reflected in the degree of profile development.

The soils in Dickinson County range from young to mature. Most of the soils that formed in glacial deposits have been exposed to the soil-forming processes long enough for the development of distinct horizons. Pemene soils are an example of these older soils. Waucedah soils are an example of young soils. They formed in recent alluvial sediments and have not been in place long enough for distinct horizons to develop.

Processes of Soil Formation

The processes responsible for the development of soil horizons in unconsolidated parent material are referred to as soil genesis. Several processes are involved in the development of horizons in the soils of Dickinson County. These were the accumulation of organic matter, the leaching of lime (calcium carbonate) and other bases, the reduction and transfer of iron, the formation and translocation of silicate clay minerals, and the formation of soil structure. More than one of these processes have helped to differentiate horizons in most of the soils.

As organic matter accumulated at the surface, an A horizon formed. In general, the A horizon in wet soils is thicker and has a higher content of organic matter than

the A horizon in well drained to excessively drained soils. The poorly drained Deford soils, for example, have an A horizon that is thicker and darker than that in the excessively drained Rubicon soils.

The leaching of carbonates and other bases has occurred in most of the soils. The leaching of bases usually precedes the translocation of silicate clay minerals. Many of the soils are moderately leached or strongly leached. Mancelona soils, for example, are leached to a depth of about 30 inches, and Pemene soils commonly are leached to a depth of more than 60 inches. Differences in the depth of leaching are primarily the result of differences in parent material.

Gleying, or the reduction and transfer of iron, is evident in somewhat poorly drained to very poorly drained soils. Hettinger soils are an example. A gray color in the B and C horizons indicates the reduction of iron.

The translocation of clay minerals has contributed to horizon development in most of the well drained and somewhat poorly drained, loamy soils in the county. An eluviated, or leached, E horizon is lower in content of clay and lighter in color than the illuviated Bt horizon. The Bt horizon typically has an accumulation of clay (clay films) in pores and on the faces of peds. These soils were probably leached of carbonates to a considerable extent before the movement of clay took place. Emmet soils are an example of soils in which clay has accumulated in the Bt horizon.

In some soils iron, aluminum, and humus have been transferred from the E horizon to the Bs horizon, which is typically dark brown, strong brown, or reddish brown. This process is particularly evident in sandy soils, such as Rubicon and Wainola soils. It also is evident in many loamy soils. Emmet soils, for example, have two sets of eluvial and illuvial horizons. The upper set, an E horizon above a Bs horizon, is the result of the movement and accumulation of iron, aluminum, and humus. The lower set, an E' horizon above a Bt horizon, is the result of the movement and accumulation of clay. This arrangement of horizons is called a bisequum.

With the passage of time, the primary soil particles of sand, silt, and clay have become combined or arranged into secondary compound particles, or peds. The causes of this aggregation may be physical processes, such as wetting and drying and freezing and thawing cycles; chemical weathering processes; and the activities of organisms, such as earthworms. Soil structure is important because it affects aeration and permeability. The ability of any soil to support plants and its response to management depend as much on soil structure as on fertility.

References

(1) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols., illus.

(2) American Society for Testing and Materials. 1985. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.

(3) Baldwin, John L. 1973. Climates of the United States. U.S. Dep. Commer., Natl. Oceanic and Atmos. Adm., Environ. Data Serv., 49 pp., illus.

(4) Coffman, M.S., E. Alyanak, J. Kotar, and J.E. Ferris. 1980. Field guide habitat classification system for Upper Peninsula of Michigan and northeast Wisconsin. Mich. Tech. Univ. (Reprinted in 1983)

(5) Jenny, Hans. 1941. Factors of soil formation. McGraw-Hill Book Company, Inc., 281 pp., illus.

(6) LeMasters, G.S., E.A. Padley, and C.C. Trettin, eds. 1984. Characterization data for selected soils of Dickinson County, Michigan. Ford For. Cent., Mich. Tech. Univ., Res. Note 39, 29 pp.

(7) Mokma, D.L., E.P. Whiteside, and I.F. Schneider. 1978. Soil management units and land use planning. Mich. State Univ., Ext. Bull. E-1262, 12 pp.

(8) Spencer, John, Jr. 1980. Timber resources of Michigan's western Upper Peninsula. North-Cent. Forest Exp. Stn., Resour. Bull. NC-60, 102 pp.

(9) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(10) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(11) United States Department of Agriculture, Soil Conservation Service. National forestry manual. (Available as a directive in the State Office of the Soil Conservation Service at East Lansing, Michigan)

Glossary

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly

drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits

are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Ice-contact drift. Glacial deposits in direct contact with melting glaciers. The physiographic features characteristic of this drift include kames and kettles.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.
Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.
Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Organic soil. Generally, a soil in which more than half of the upper 32 inches is organic or in which organic soil material of any thickness rests on bedrock.

Organic soil material. Soil material in which the content of organic carbon ranges from 12 to more than 18 percent, depending on the content of clay.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rock outcrop. Exposed bedrock; commonly on the crest and sides of hills and ridges.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from

gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and

are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Dashes indicate data were not available. All data at Iron Mountain and most precipitation data at Crystal Falls recorded in the period 1951-80. Snowfall data at Crystal Falls recorded in the period 1953-80. Temperature data at Crystal Falls recorded in the period 1962-80)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
IRON MOUNTAIN:											
January---	23.0	3.2	13.1	43	-26	0	1.13	0.6	1.6	4	14.3
February--	27.8	5.3	16.5	48	-24	0	.96	.4	1.5	4	11.3
March-----	37.6	15.5	26.5	61	-15	3	1.72	.8	2.5	4	11.7
April-----	53.5	29.2	41.4	83	7	37	2.62	1.4	3.7	6	4.3
May-------	67.1	40.2	53.6	89	21	184	3.35	2.2	4.4	7	.5
June------	75.3	49.8	62.6	92	30	387	3.85	2.4	5.1	8	Trace
July------	79.6	54.7	67.2	95	38	540	3.65	2.2	5.0	7	.0
August----	76.9	53.0	64.9	92	35	471	4.01	2.2	5.6	7	.0
September-	67.3	45.1	56.2	88	24	222	3.54	1.8	5.0	7	Trace
October---	57.0	36.2	46.6	80	17	71	2.28	.9	3.4	5	.3
November--	40.3	24.3	32.3	65	-1	5	1.78	1.0	2.5	4	6.0
December--	27.6	11.0	19.3	48	-18	0	1.47	.8	2.0	4	14.9
Year----	52.8	30.6	41.7	96	-27	1,920	30.36	26.0	34.6	67	63.3
CRYSTAL FALLS:											
January---	19.5	-3.0	8.2	43	-34	---	1.18	0.5	1.7	4	15.5
February--	23.8	-2.9	10.5	48	-35	---	1.02	.4	1.5	3	12.1
March-----	35.7	10.2	22.9	62	-26	---	1.73	.8	2.5	4	11.6
April-----	50.0	25.5	37.8	82	-2	---	2.39	1.5	3.2	6	4.2
May-------	64.9	36.9	50.9	90	17	---	3.20	2.1	4.2	7	.6
June------	73.1	46.1	59.6	92	28	---	3.96	2.6	5.2	8	.0
July------	78.2	50.7	64.4	95	35	---	3.80	2.2	5.2	8	.0
August----	75.2	48.3	61.7	92	30	---	3.49	1.9	4.9	6	.0
September-	65.6	40.9	53.2	87	23	---	3.46	1.8	4.9	7	.0
October---	54.5	32.6	43.6	80	13	---	2.18	1.0	3.2	5	.7
November--	38.0	21.5	29.7	64	-7	---	1.91	1.1	2.6	5	9.0
December--	24.9	6.0	15.5	45	-25	---	1.45	.9	2.0	4	16.9
Year----	50.3	26.0	38.2	96	-37	---	29.77	26.0	33.5	67	70.6

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1930-79 at Iron Mountain, Michigan)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 19	May 30	June 12
2 years in 10 later than--	May 14	May 25	June 7
5 years in 10 later than--	May 5	May 16	May 29
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 20	Sept. 11	Sept. 4
2 years in 10 earlier than--	Sept. 26	Sept. 16	Sept. 8
5 years in 10 earlier than--	Oct. 8	Sept. 26	Sept. 17

TABLE 3.--GROWING SEASON

(Recorded in the period 1930-79 at Iron Mountain, Michigan)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	131	110	91
8 years in 10	140	118	98
5 years in 10	156	133	111
2 years in 10	172	148	124
1 year in 10	181	156	130

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
10	Waucedah-Cathro complex	16,700	3.4
13B	Pemene fine sandy loam, 0 to 6 percent slopes	33,970	6.8
13D	Pemene fine sandy loam, 6 to 18 percent slopes	48,910	9.8
13F	Pemene fine sandy loam, 18 to 35 percent slopes	9,500	1.9
14B	Fence very fine sandy loam, 0 to 6 percent slopes	1,330	0.3
14D	Fence very fine sandy loam, 6 to 18 percent slopes	320	0.1
15	Carbondale and Cathro mucks	101,370	20.4
17	Greenwood and Dawson peats	4,780	1.0
20B	Karlin loamy fine sand, 0 to 6 percent slopes	2,790	0.6
20D	Karlin loamy fine sand, 6 to 18 percent slopes	2,130	0.4
20F	Karlin loamy fine sand, 18 to 35 percent slopes	710	0.1
23B	Escanaba loamy fine sand, 0 to 6 percent slopes	5,130	1.0
23D	Escanaba loamy fine sand, 6 to 18 percent slopes	2,710	0.5
24B	Emmet fine sandy loam, 0 to 6 percent slopes	35,610	7.2
24D	Emmet fine sandy loam, 6 to 18 percent slopes	49,320	9.9
24F	Emmet fine sandy loam, 18 to 35 percent slopes	9,130	1.8
25B	Pence fine sandy loam, 0 to 6 percent slopes	6,460	1.3
25D	Pence fine sandy loam, 6 to 18 percent slopes	1,790	0.4
25F	Pence fine sandy loam, 18 to 35 percent slopes	1,120	0.2
26	Deford fine sand	4,780	1.0
32A	Rousseau fine sand, moderately wet, 0 to 3 percent slopes	3,980	0.8
35B	Nadeau fine sandy loam, 0 to 6 percent slopes	3,170	0.6
35D	Nadeau fine sandy loam, 6 to 18 percent slopes	2,430	0.5
35F	Nadeau fine sandy loam, 18 to 35 percent slopes	690	0.1
36B	Rousseau fine sand, 0 to 6 percent slopes	5,830	1.2
36D	Rousseau fine sand, 6 to 18 percent slopes	2,600	0.5
36F	Rousseau fine sand, 18 to 35 percent slopes	690	0.1
46B	Oconto fine sandy loam, 0 to 6 percent slopes	3,020	0.6
46D	Oconto fine sandy loam, 6 to 18 percent slopes	1,500	0.3
47A	Wainola fine sand, 0 to 3 percent slopes	2,590	0.5
49B	Mancelona loamy sand, 0 to 6 percent slopes	5,610	1.1
49D	Mancelona loamy sand, 6 to 18 percent slopes	3,370	0.7
49F	Mancelona loamy sand, 18 to 35 percent slopes	1,040	0.2
50	Pits	610	0.1
55	Kinross mucky fine sand	1,120	0.2
57B	Vilas loamy sand, 0 to 6 percent slopes	3,710	0.7
57D	Vilas loamy sand, 6 to 18 percent slopes	1,460	0.3
57F	Vilas loamy sand, 18 to 35 percent slopes	750	0.2
59A	Channing fine sandy loam, 0 to 3 percent slopes	1,450	0.3
60B	Zimmerman fine sand, 0 to 6 percent slopes	6,670	1.3
60D	Zimmerman fine sand, 6 to 18 percent slopes	7,040	1.4
60F	Zimmerman fine sand, 18 to 35 percent slopes	2,070	0.4
64B	Rubicon sand, 0 to 6 percent slopes	4,220	0.9
64D	Rubicon sand, 6 to 18 percent slopes	2,460	0.5
64F	Rubicon sand, 18 to 35 percent slopes	1,330	0.3
65	Pits and Dumps, mine	1,780	0.4
66D	Zimmerman-Rock outcrop complex, 6 to 18 percent slopes	550	0.1
66F	Zimmerman-Rock outcrop complex, 18 to 35 percent slopes	530	0.1
67	Udorthents, loamy	1,270	0.3
68D	Pemene-Rock outcrop complex, 6 to 18 percent slopes	13,920	2.8
68F	Pemene-Rock outcrop complex, 18 to 35 percent slopes	4,450	0.9
69D	Emmet-Rock outcrop complex, 6 to 18 percent slopes	12,360	2.5
69F	Emmet-Rock outcrop complex, 18 to 35 percent slopes	2,400	0.5
70B	Solona fine sandy loam, 0 to 4 percent slopes	11,920	2.4
71	Ensley fine sandy loam	15,440	3.1
72	Aquents and Histosols, ponded	1,480	0.3
75B	Alstad loam, 0 to 6 percent slopes	690	0.1
76B	Emmet-Pemene fine sandy loams, 0 to 6 percent slopes	2,840	0.6
76D	Emmet-Pemene fine sandy loams, 6 to 18 percent slopes	5,370	1.1
77D	Rock outcrop-Pemene complex, 6 to 18 percent slopes	2,010	0.4
77F	Rock outcrop-Pemene complex, 18 to 35 percent slopes	3,220	0.6
79	Hettinger silt loam	310	0.1
80B	Longrie fine sandy loam, 0 to 6 percent slopes	1,970	0.4

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
80D	Longrie fine sandy loam, 6 to 18 percent slopes	730	0.1
82B	Ubly Variant very fine sandy loam, 2 to 6 percent slopes	180	*
82D	Ubly Variant very fine sandy loam, 6 to 18 percent slopes	280	0.1
	Water	5,878	1.2
	Total	497,548	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
13B	Pemene fine sandy loam, 0 to 6 percent slopes
14B	Fence very fine sandy loam, 0 to 6 percent slopes
24B	Emmet fine sandy loam, 0 to 6 percent slopes
46B	Oconto fine sandy loam, 0 to 6 percent slopes
70B	Solona fine sandy loam, 0 to 4 percent slopes (where drained)
71	Ensley fine sandy loam (where drained)
75B	Alstad loam, 0 to 6 percent slopes (where drained)
76B	Emmet-Pemene fine sandy loams, 0 to 6 percent slopes
79	Hettinger silt loam (where drained)
82B	Ubly Variant very fine sandy loam, 2 to 6 percent slopes

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS

(Yields in the N columns are for nonirrigated soils; those in the I columns are for irrigated soils. Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability		Irish potatoes		Oats	Barley	Corn		Corn silage	Alfalfa hay
	N	I	N	I	N	N	N	I	N	N
			Cwt	Cwt	Bu	Bu	Bu	Bu	Tons	Tons
10--Waucedah-Cathro	VIw	---	---	---	---	---	---	---	---	---
13B--Pemene	IIIs	IIe	250	350	60	40	70	---	11	3.0
13D--Pemene	IVe	---	---	---	50	35	---	---	---	---
13F--Pemene	VIIe	---	---	---	---	---	---	---	---	---
14B--Fence	IIe	IIe	350	375	80	55	90	---	15	4.0
14D--Fence	IVe	---	---	---	70	---	---	---	---	3.5
15--Carbondale and Cathro	VIw	---	---	---	---	---	---	---	---	---
17--Greenwood and Dawson	VIIw	---	---	---	---	---	---	---	---	---
20B--Karlin	IIIs	IIIs	250	350	60	40	70	---	13	3.0
20D--Karlin	IVe	---	---	---	55	---	---	---	---	2.5
20F--Karlin	VIIe	---	---	---	---	---	---	---	---	---
23B--Escanaba	IIIs	IIIs	275	350	70	40	75	---	12	3.5
23D--Escanaba	IVe	---	---	---	55	30	---	---	---	3.1
24B--Emmet	IIe	IIe	325	350	75	50	75	---	15	3.5
24D--Emmet	IVe	---	---	---	70	45	---	---	---	3.2
24F--Emmet	VIIe	---	---	---	---	---	---	---	---	---
25B--Pence	IIIe	IIe	250	350	60	40	70	---	10	3.0
25D--Pence	IVe	---	---	---	55	35	---	---	---	2.7
25F--Pence	VIIe	---	---	---	---	---	---	---	---	---

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability		Irish potatoes		Oats	Barley	Corn		Corn silage	Alfalfa hay
	N	I	N	I	N	N	N	I	N	N
			Cwt	Cwt	Bu	Bu	Bu	Bu	Tons	Tons
26---------- Deford	Vw	---	---	---	---	---	---	---	---	---
32A---------- Rousseau	IIIs	IIIs	250	350	60	---	70	---	10	3.0
35B---------- Nadeau	IIIs	IIe	275	350	70	45	70	---	11	3.0
35D---------- Nadeau	IVe	---	---	---	65	40	---	---	---	2.6
35F---------- Nadeau	VIIe	---	---	---	---	---	---	---	---	---
36B---------- Rousseau	IIIs	IIIs	225	350	50	35	60	---	10	2.8
36D---------- Rousseau	IVe	---	---	---	45	---	---	---	---	2.2
36F---------- Rousseau	VIIe	---	---	---	---	---	---	---	---	---
46B---------- Oconto	IIe	IIe	275	350	70	45	70	---	11	3.0
46D---------- Oconto	IVe	---	---	---	65	40	50	---	8	2.5
47A---------- Wainola	IIIw	---	---	---	60	45	70	---	14	3.0
49B---------- Mancelona	IIIs	IIIs	250	350	60	40	70	---	13	3.0
49D---------- Mancelona	IVe	---	---	---	55	---	---	---	---	2.7
49F---------- Mancelona	VIIe	---	---	---	---	---	---	---	---	---
50*. Pits										
55---------- Kinross	VIw	---	---	---	---	---	---	---	---	---
57B---------- Vilas	IVs	IIIs	200	325	40	---	50	---	8	2.5
57D, 57F--------- Vilas	VIIs	---	---	---	---	---	---	---	---	---
59A---------- Channing	IIIw	---	---	---	65	45	70	---	11	3.0
60B---------- Zimmerman	IIIs	IIIs	250	350	60	40	70	---	10	3.0

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability		Irish potatoes		Oats	Barley	Corn		Corn silage	Alfalfa hay
	N	I	N	I	N	N	N	I	N	N
			Cwt	Cwt	Bu	Bu	Bu	Bu	Tons	Tons
60D---------- Zimmerman	IVe	---	---	---	55	35	---	---	---	2.7
60F---------- Zimmerman	VIIe	---	---	---	---	---	---	---	---	---
64B---------- Rubicon	VIs	---	---	---	---	---	---	---	---	2.0
64D, 64F----- Rubicon	VIIs	---	---	---	---	---	---	---	---	---
65*. Pits and Dumps										
66D*--------- Zimmerman-Rock outcrop	VIIe	---	---	---	---	---	---	---	---	---
66F*--------- Zimmerman-Rock outcrop	VIIe	---	---	---	---	---	---	---	---	---
67. Udorthents										
68D*--------- Pemene-Rock outcrop	VIe	---	---	---	---	---	---	---	---	---
68F*--------- Pemene-Rock outcrop	VIIe	---	---	---	---	---	---	---	---	---
69D*--------- Emmet-Rock outcrop	VIe	---	---	---	---	---	---	---	---	---
69F*--------- Emmet-Rock outcrop	VIIe	---	---	---	---	---	---	---	---	---
70B---------- Solona	IIw	---	---	---	80	55	80	---	14	3.5
71----------- Ensley	Vw	---	---	---	---	---	---	---	---	---
72. Aquents and Histosols										
75B---------- Alstad	IIw	---	---	---	85	60	90	---	14	4.0
76B---------- Emmet-Pemene	IIe	IIe	300	350	70	45	76	---	14	3.5
76D---------- Emmet-Pemene	IVe	---	---	---	65	40	---	---	---	3.3

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability		Irish potatoes		Oats	Barley	Corn		Corn silage	Alfalfa hay
	N	I	N	I	N	N	N	I	N	N
			Cwt	Cwt	Bu	Bu	Bu	Bu	Tons	Tons
77D--Rock outcrop-Pemene	VIIe	---	---	---	---	---	---	---	---	---
77F--Rock outcrop-Pemene	VIIe	---	---	---	---	---	---	---	---	---
79--Hettinger	Vw	---	---	---	---	---	---	---	---	---
80B--Longrie	IIIe	IIIe	275	350	70	45	70	---	11	3.0
80D--Longrie	IVe	---	---	---	65	40	---	---	---	2.7
82B--Ubly Variant	IIe	IIe	350	375	65	---	80	---	15	3.8
82D--Ubly Variant	IVe	---	---	---	60	---	70	---	14	3.8

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--CAPABILITY CLASSES AND SUBCLASSES

(Miscellaneous areas are excluded. Absence of an entry indicates no acreage)

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	---	---	---	---
II	55,590	43,670	11,920	---
III	79,620	8,430	4,040	67,150
IV	132,210	128,500	---	3,710
V	20,530	---	20,530	---
VI	149,690	26,280	119,190	4,220
VII	48,890	37,030	4,780	7,080
VIII	---	---	---	---

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
10**:									
Waucedah	3W	Slight	Severe	Severe	Severe	Northern white-cedar	30	42	
						Balsam fir	40	71	
						Black ash	35	16	
						Quaking aspen	40	22	
						Red maple	---	---	
						Black spruce	---	---	
Cathro	5W	Slight	Severe	Severe	Severe	Balsam fir	40	71	
						Northern white-cedar	15	20	
						Tamarack	35	23	
						Paper birch	---	---	
						Red maple	---	---	
						Black spruce	15	23	
						White spruce	---	---	
13B, 13D Pemene	4S	Slight	Slight	Slight	Slight	Northern red oak	65	59	Red pine, white spruce, Norway spruce.
						Red maple	---	---	
						Sugar maple	60	38	
						Paper birch	---	---	
						Quaking aspen	---	---	
						Bigtooth aspen	---	---	
						Eastern white pine	---	---	
						Red pine	---	---	
						American basswood	---	---	
13F Pemene	4R	Moderate	Moderate	Slight	Slight	Northern red oak	65	59	Red pine, white spruce, Norway spruce.
						Red maple	---	---	
						Sugar maple	60	38	
						Paper birch	---	---	
						Quaking aspen	---	---	
						Bigtooth aspen	---	---	
						Eastern white pine	---	---	
						Red pine	---	---	
						American basswood	---	---	
14B, 14D Fence	3A	Slight	Slight	Slight	Slight	Sugar maple	65	40	Red pine, eastern white pine, white spruce.
						Yellow birch	---	---	
						American basswood	---	---	
						Quaking aspen	---	---	
						Bigtooth aspen	---	---	
15**:									
Carbondale	5W	Slight	Severe	Severe	Severe	Balsam fir	40	71	
						Black spruce	15	23	
						Northern white-cedar	---	---	
						Tamarack	---	---	
Cathro	5W	Slight	Severe	Severe	Severe	Balsam fir	40	71	
						Northern white-cedar	15	20	
						Tamarack	35	23	
						Paper birch	---	---	
						Red maple	---	---	
						Black spruce	15	23	
						White spruce	---	---	

See footnotes at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
17**:									
Greenwood	2W	Slight	Severe	Severe	Severe	Black spruce	15	23	
						Tamarack	---	---	
Dawson	2W	Slight	Severe	Severe	Severe	Black spruce	15	23	
						Tamarack	---	---	
20B, 20D Karlin	3S	Slight	Slight	Moderate	Slight	Sugar maple	61	38	Red pine, eastern white pine.
						Bigtooth aspen	---	---	
						Northern red oak	---	---	
						Red pine	---	---	
						Eastern white pine	---	---	
20F Karlin	3R	Moderate	Moderate	Moderate	Slight	Sugar maple	61	38	Red pine, eastern white pine.
						Bigtooth aspen	---	---	
						Northern red oak	---	---	
						Red pine	---	---	
						Eastern white pine	---	---	
23B, 23D Escanaba	3S	Slight	Moderate	Moderate	Slight	Sugar maple	60	38	Red pine, white spruce.
						Basswood	---	---	
						Red maple	---	---	
						Bigtooth aspen	---	---	
						Quaking aspen	---	---	
						Eastern white pine	75	166	
						Red pine	---	---	
24B, 24D Emmet	3A	Slight	Moderate	Slight	Slight	Sugar maple	66	41	Red pine, eastern white pine, white spruce.
						Bigtooth aspen	---	---	
						Yellow birch	---	---	
						American basswood	---	---	
						Eastern white pine	---	---	
						Northern red oak	74	72	
24F Emmet	3R	Moderate	Moderate	Slight	Slight	Sugar maple	66	41	Red pine, eastern white pine, white spruce.
						Bigtooth aspen	---	---	
						Yellow birch	---	---	
						American basswood	---	---	
						Eastern white pine	---	---	
						Northern red oak	74	72	
25B Pence	7S	Slight	Slight	Moderate	Slight	Red pine	59	99	Red pine, eastern white pine, jack pine.
						Balsam fir	---	---	
						Quaking aspen	---	---	
						Paper birch	---	---	
						Yellow birch	---	---	
25D, 25F Pence	7R	Moderate	Moderate	Moderate	Slight	Red pine	59	99	Red pine, eastern white pine, jack pine.
						Balsam fir	---	---	
						Quaking aspen	---	---	
						Paper birch	---	---	
						Yellow birch	---	---	
26 Deford	4W	Slight	Severe	Severe	Severe	Quaking aspen	60	64	
						Balsam fir	---	---	
						Northern white-cedar	---	---	
						Red maple	---	---	

See footnotes at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
32A---------- Rousseau	5S	Slight	Moderate	Moderate	Slight	Quaking aspen-------	65	73	Red pine, jack pine.
						Red maple----------	---	---	
						Balsam fir----------	---	---	
						Northern red oak----	---	---	
						Eastern white pine--	---	---	
						Red pine-----------	---	---	
						Paper birch---------	65	73	
35B, 35D-------- Nadeau	2S	Slight	Slight	Slight	Moderate	Sugar maple---------	55	35	Red pine, eastern white pine.
						Quaking aspen-------	---	---	
						Bigtooth aspen------	63	70	
						Northern red oak----	65	48	
						Eastern white pine--	---	---	
						White ash----------	---	---	
						White spruce--------	---	---	
35F---------- Nadeau	2R	Moderate	Moderate	Slight	Moderate	Sugar maple---------	55	35	Red pine, eastern white pine.
						Quaking aspen-------	---	---	
						Bigtooth aspen------	63	70	
						Northern red oak----	65	59	
						Eastern white pine--	---	---	
						White ash----------	---	---	
36B, 36D-------- Rousseau	5S	Slight	Moderate	Moderate	Slight	Quaking aspen-------	65	73	Red pine, jack pine.
						Red maple----------	---	---	
						Balsam fir----------	---	---	
						Northern red oak----	---	---	
						Eastern white pine--	---	---	
						Red pine-----------	---	---	
						Paper birch---------	65	62	
36F---------- Rousseau	5R	Moderate	Moderate	Moderate	Slight	Quaking aspen-------	65	73	Red pine, jack pine.
						Red maple----------	---	---	
						Balsam fir----------	---	---	
						Northern red oak----	---	---	
						Eastern white pine--	---	---	
						Red pine-----------	---	---	
						Paper birch---------	65	73	
46B, 46D-------- Oconto	3A	Slight	Slight	Slight	Slight	Sugar maple---------	60	38	Eastern white pine, red pine, white spruce.
						American basswood---	---	---	
						White ash----------	---	---	
						Northern red oak----	---	---	
47A---------- Wainola	6W	Slight	Moderate	Slight	Moderate	Quaking aspen-------	70	81	White spruce, Norway spruce, eastern white pine.
						Red maple----------	57	36	
49B, 49D-------- Mancelona	3S	Slight	Slight	Moderate	Slight	Sugar maple---------	61	38	Red pine, eastern white pine, jack pine.
						Northern red oak----	---	---	
						Red pine-----------	---	---	
						Jack pine----------	---	---	
						Quaking aspen-------	---	---	

See footnotes at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
49F---------- Mancelona	3R	Moderate	Moderate	Moderate	Slight	Sugar maple--------- Northern red oak---- Red pine---------- Jack pine---------- Quaking aspen-------	61 --- --- --- ---	38 --- --- --- ---	Red pine, eastern white pine, jack pine.
55---------- Kinross	2W	Slight	Severe	Severe	Severe	Quaking aspen------- Black spruce-------- Tamarack---------- Jack pine---------- Balsam fir---------- Red maple----------	45 --- --- --- --- ---	32 --- --- --- --- ---	
57B, 57D-------- Vilas	6S	Slight	Moderate	Moderate	Slight	Red pine---------- Jack pine---------- Eastern white pine-- Balsam fir---------- Quaking aspen-------	57 65 56 --- ---	93 94 109 --- ---	Red pine, eastern white pine, jack pine.
57F---------- Vilas	6R	Moderate	Moderate	Moderate	Slight	Red pine---------- Jack pine---------- Eastern white pine-- Balsam fir---------- Quaking aspen-------	57 65 56 --- ---	93 94 109 --- ---	Red pine, eastern white pine, jack pine.
59A---------- Channing	2W	Slight	Moderate	Slight	Moderate	Red maple---------- Quaking aspen------- Balsam fir---------- Paper birch--------- Black spruce-------- White spruce-------- Northern white-cedar	55 --- --- --- --- --- ---	35 --- --- --- --- --- ---	Eastern white pine, white spruce.
60B, 60D-------- Zimmerman	8S	Slight	Moderate	Moderate	Slight	Red pine---------- Quaking aspen------- Jack pine---------- Paper birch---------	64 70 77 ---	112 81 116 ---	Red pine, jack pine, eastern white pine, white spruce.
60F---------- Zimmerman	8R	Moderate	Moderate	Moderate	Slight	Red pine---------- Quaking aspen------- Red maple---------- Jack pine---------- Paper birch---------	64 70 --- 77 ---	112 81 --- 116 ---	Red pine, jack pine, eastern white pine, white spruce.
64B, 64D-------- Rubicon	4S	Slight	Moderate	Moderate	Slight	Quaking aspen------- Jack pine---------- Red pine---------- Bigtooth aspen------ Balsam fir---------- Red maple---------- Eastern white pine--	60 53 50 --- 48 --- 45	64 73 75 --- 90 --- 75	Red pine, jack pine.

See footnotes at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
64F---------- Rubicon	4R	Moderate	Moderate	Moderate	Slight	Quaking aspen-------	60	64	Red pine, jack pine.
						Jack pine----------	53	73	
						Red pine----------	50	75	
						Bigtooth aspen------	---	---	
						Balsam fir----------	48	90	
						Red maple----------	---	---	
						Eastern white pine--	45	75	
66D**: Zimmerman------	8S	Slight	Moderate	Moderate	Slight	Red pine----------	64	112	Red pine, jack pine, eastern white pine, white spruce.
						Quaking aspen-------	70	81	
						Jack pine----------	77	116	
						Paper birch---------	---	---	
Rock outcrop.									
66F**: Zimmerman------	8R	Moderate	Moderate	Moderate	Slight	Red pine----------	64	112	Red pine, jack pine, eastern white pine, white spruce.
						Quaking aspen-------	70	81	
						Jack pine----------	65	94	
						Paper birch---------	---	---	
Rock outcrop.									
68D**: Pemene---------	4S	Slight	Moderate	Slight	Slight	Northern red oak----	65	59	Red pine, white spruce, Norway spruce.
						Red maple----------	---	---	
						Sugar maple---------	60	38	
						Paper birch---------	---	---	
						Quaking aspen-------	---	---	
						Bigtooth aspen------	---	---	
						Eastern white pine--	---	---	
						Red pine----------	---	---	
						American basswood---	---	---	
Rock outcrop.									
68F**: Pemene---------	4R	Moderate	Moderate	Slight	Slight	Northern red oak----	65	59	Red pine, white spruce, Norway spruce.
						Red maple----------	---	---	
						Sugar maple---------	60	38	
						Paper birch---------	---	---	
						Quaking aspen-------	---	---	
						Bigtooth aspen------	---	---	
						Eastern white pine--	---	---	
						Red pine----------	---	---	
						American basswood---	---	---	
Rock outcrop.									
69D**: Emmet----------	3A	Slight	Slight	Slight	Slight	Sugar maple---------	66	41	Red pine, eastern white pine, white spruce.
						Bigtooth aspen------	---	---	
						Yellow birch--------	---	---	
						American basswood---	---	---	
						Eastern white pine--	---	---	
						Northern red oak----	74	72	
Rock outcrop.									

See footnotes at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
69F**:									
Emmet	3R	Moderate	Moderate	Slight	Slight	Sugar maple	66	41	Red pine, eastern white pine, white spruce.
						Bigtooth aspen	---	---	
						Yellow birch	---	---	
						American basswood	---	---	
						Eastern white pine	---	---	
						Northern red oak	74	72	
Rock outcrop.									
70B	3W	Slight	Moderate	Slight	Moderate	Sugar maple	64	40	Eastern white pine, white ash, white spruce.
Solona						Red maple	---	---	
						White ash	---	---	
						American basswood	---	---	
						Quaking aspen	---	---	
71	3W	Slight	Severe	Severe	Severe	Red maple	62	39	
Ensley						Balsam fir	60	118	
						White spruce	---	---	
						Black ash	---	---	
						Northern white-cedar	---	---	
75B	3W	Slight	Moderate	Slight	Moderate	Red maple	65	40	Eastern white pine, white spruce.
Alstad						American basswood	---	---	
						Sugar maple	---	---	
						Quaking aspen	---	---	
						Bigtooth aspen	---	---	
76B**, 76D**:									
Emmet	3A	Slight	Slight	Slight	Slight	Sugar maple	66	41	Red pine, eastern white pine, white spruce.
						Bigtooth aspen	---	---	
						Yellow birch	---	---	
						American basswood	---	---	
						Eastern white pine	---	---	
						Northern red oak	74	56	
Pemene	4S	Slight	Moderate	Slight	Slight	Northern red oak	65	59	Red pine, white spruce, Norway spruce.
						Red maple	---	---	
						Sugar maple	60	38	
						Paper birch	---	---	
						Quaking aspen	---	---	
						Bigtooth aspen	---	---	
						Eastern white pine	---	---	
						Red pine	---	---	
						American basswood	---	---	
77D**:									
Rock outcrop.									
Pemene	4S	Slight	Slight	Slight	Slight	Northern red oak	65	59	Red pine, white spruce, Norway spruce.
						Red maple	---	---	
						Sugar maple	60	38	
						Paper birch	---	---	
						Quaking aspen	---	---	
						Bigtooth aspen	---	---	
						Eastern white pine	---	---	
						Red pine	---	---	
						American basswood	---	---	

See footnotes at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
77F**: Rock outcrop.									
Pemene	4R	Moderate	Moderate	Moderate	Slight	Northern red oak	65	39	Red pine, white spruce, Norway spruce.
						Red maple	---	---	
						Sugar maple	60	38	
						Paper birch	---	---	
						Quaking aspen	---	---	
						Bigtooth aspen	---	---	
						Eastern white pine	---	---	
						Red pine	---	---	
						American basswood	---	---	
79 Hettinger	6W	Slight	Severe	Severe	Severe	Balsam fir	45	83	
						Black ash	---	---	
						Quaking aspen	---	---	
						Northern white-cedar	---	---	
80B, 80D Longrie	3A	Slight	Slight	Slight	Moderate	Sugar maple	61	38	Norway spruce, red pine, white spruce.
						Yellow birch	---	---	
						American beech	---	---	
						Quaking aspen	---	---	
						Red pine	---	---	
						American basswood	---	---	
						Black cherry	---	---	
						Balsam fir	---	---	
82B, 82D Ubly Variant	3D	Slight	Slight	Slight	Moderate	Sugar maple	66	41	Red pine, eastern white pine, white spruce.
						American basswood	---	---	
						Quaking aspen	---	---	

* Volume is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked, even-aged, unmanaged stands.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Ratings for most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
	Logging areas and skid trails	Landings	Logging roads		Logging areas and skid trails	Landings	Logging roads
10*:							
Waucedah	Severe: wetness.	Severe: wetness.	Severe: wetness.	Winter	Slight	Slight	Slight.
Cathro	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter	Moderate: low strength.	Severe: low strength.	Moderate: low strength.
13B Pemene	Slight	Slight	Slight	Year round.	Slight	Slight	Slight.
13D Pemene	Slight	Severe: slope.	Slight	Year round.	Slight	Severe: slope.	Slight.
13F Pemene	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.	Moderate: slope.
14B Fence	Slight	Slight	Slight	Year round.	Slight	Slight	Slight.
14D Fence	Slight	Severe: slope.	Slight	Year round.	Slight	Severe: slope.	Slight.
15*:							
Carbondale	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter	Moderate: low strength.	Severe: low strength.	Moderate: low strength.
Cathro	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter	Moderate: low strength.	Severe: low strength.	Moderate: low strength.
17*:							
Greenwood	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter	Moderate: low strength.	Severe: low strength.	Moderate: low strength.
Dawson	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter	Moderate: low strength.	Severe: low strength.	Moderate: low strength.
20B Karlin	Slight	Slight	Slight	Year round.	Slight	Slight	Slight.

See footnote at end of table.

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND--Continued

Soil name and map symbol	Ratings for most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
	Logging areas and skid trails	Landings	Logging roads		Logging areas and skid trails	Landings	Logging roads
20D---------- Karlin	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.	Slight.
20F---------- Karlin	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.	Moderate: slope.
23B---------- Escanaba	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight--------	Slight.
23D---------- Escanaba	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.	Slight.
24B---------- Emmet	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight--------	Slight.
24D---------- Emmet	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.	Slight.
24F---------- Emmet	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.	Moderate: slope.
25B---------- Pence	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight--------	Slight.
25D---------- Pence	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.	Slight.
25F---------- Pence	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.	Moderate: slope.
26---------- Deford	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, winter.	Slight---------	Slight--------	Slight.
32A---------- Rousseau	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Spring, fall, winter.	Slight---------	Slight--------	Slight.
35B---------- Nadeau	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight--------	Slight.
35D---------- Nadeau	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.	Slight.
35F---------- Nadeau	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.	Moderate: slope.

See footnote at end of table.

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND--Continued

Soil name and map symbol	Ratings for most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
	Logging areas and skid trails	Landings	Logging roads		Logging areas and skid trails	Landings	Logging roads
36B---------- Rousseau	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Spring, fall, winter.	Slight---------	Slight---------	Slight.
36D---------- Rousseau	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.	Spring, fall, winter.	Slight---------	Severe: slope.	Slight.
36F---------- Rousseau	Moderate: slope, too sandy.	Severe: slope.	Moderate: slope, too sandy.	Spring, fall, winter.	Moderate: slope.	Severe: slope.	Moderate: slope.
46B---------- Oconto	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight---------	Slight.
46D---------- Oconto	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.	Slight.
47A---------- Wainola	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Summer, fall, winter.	Slight---------	Slight---------	Slight.
49B---------- Mancelona	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight---------	Slight.
49D---------- Mancelona	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.	Slight.
49F---------- Mancelona	Moderate: slope.	Severe: slope.	Moderate: slope.	Year round.	Moderate: slope.	Severe: slope.	Moderate: slope.
55---------- Kinross	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, winter.	Slight---------	Slight---------	Slight.
57B---------- Vilas	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Spring, fall, winter.	Slight---------	Slight---------	Slight.
57D---------- Vilas	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.	Spring, fall, winter.	Slight---------	Severe: slope.	Slight.
57F---------- Vilas	Moderate: slope, too sandy.	Severe: slope.	Moderate: slope, too sandy.	Spring, fall, winter.	Moderate: slope.	Severe: slope.	Moderate: slope.
59A---------- Channing	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, winter.	Slight---------	Slight---------	Slight.

See footnote at end of table.

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND--Continued

Soil name and map symbol	Ratings for most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
	Logging areas and skid trails	Landings	Logging roads		Logging areas and skid trails	Landings	Logging roads
60B---------- Zimmerman	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Spring, fall, winter.	Slight---------	Slight--------	Slight.
60D---------- Zimmerman	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.	Spring, fall, winter.	Slight---------	Severe: slope.	Slight.
60F---------- Zimmerman	Moderate: slope, too sandy.	Severe: slope.	Moderate: slope, too sandy.	Spring, fall, winter.	Moderate: slope.	Severe: slope.	Moderate: slope.
64B---------- Rubicon	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Spring, fall, winter.	Slight---------	Slight--------	Slight.
64D---------- Rubicon	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.	Spring, fall, winter.	Slight---------	Severe: slope.	Slight.
64F---------- Rubicon	Moderate: slope, too sandy.	Severe: slope.	Moderate: slope, too sandy.	Spring, fall, winter.	Moderate: slope.	Severe: slope.	Moderate: slope.
66D*: Zimmerman--------	Moderate: rock outcrop, too sandy.	Severe: slope.	Moderate: rock outcrop, too sandy.	Spring, fall, winter.	Moderate: rock outcrop.	Severe: slope.	Moderate: rock outcrop.
Rock outcrop.							
66F*: Zimmerman--------	Moderate: slope, rock outcrop, too sandy.	Severe: slope.	Moderate: slope, rock outcrop, too sandy.	Spring, fall, winter.	Moderate: slope, rock outcrop.	Severe: slope.	Moderate: slope, rock outcrop.
Rock outcrop.							
68D*: Pemene----------	Moderate: rock outcrop.	Severe: slope.	Moderate: rock outcrop.	Year round.	Moderate: rock outcrop.	Severe: slope.	Moderate: rock outcrop.
Rock outcrop.							

See footnote at end of table.

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND--Continued

Soil name and map symbol	Ratings for most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
	Logging areas and skid trails	Landings	Logging roads		Logging areas and skid trails	Landings	Logging roads
68F*:							
Pemene	Moderate: slope, rock outcrop.	Severe: slope.	Moderate: slope, rock outcrop.	Year round.	Moderate: slope, rock outcrop.	Severe: slope.	Moderate: slope, rock outcrop.
Rock outcrop.							
69D*:							
Emmet	Moderate: rock outcrop.	Severe: slope.	Moderate: rock outcrop.	Year round.	Moderate: rock outcrop.	Severe: slope.	Moderate: rock outcrop.
Rock outcrop.							
69F*:							
Emmet	Moderate: slope, rock outcrop.	Severe: slope.	Moderate: slope, rock outcrop.	Year round.	Moderate: slope, rock outcrop.	Severe: slope.	Moderate: slope, rock outcrop.
Rock outcrop.							
70B---------- Solona	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, fall, winter.	Slight---------	Slight---------	Slight.
71---------- Ensley	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, winter.	Slight---------	Slight---------	Slight.
75B---------- Alstad	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, winter.	Slight---------	Slight---------	Slight.
76B*:							
Emmet	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight---------	Slight.
Pemene	Slight---------	Slight---------	Slight---------	Year round.	Slight---------	Slight---------	Slight.
76D*:							
Emmet	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.	Slight.
Pemene	Slight---------	Severe: slope.	Slight---------	Year round.	Slight---------	Severe: slope.	Slight.
77D*:							
Rock outcrop.							

See footnote at end of table.

TABLE 9.--EQUIPMENT LIMITATIONS ON WOODLAND--Continued

Soil name and map symbol	Ratings for most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
	Logging areas and skid trails	Landings	Logging roads		Logging areas and skid trails	Landings	Logging roads
77D*: Pemene	Severe: rock outcrop.	Severe: slope, rock outcrop.	Severe: rock outcrop.	Year round.	Severe: rock outcrop.	Severe: slope, rock outcrop.	Severe: rock outcrop.
77F*: Rock outcrop.							
Pemene	Severe: slope, rock outcrop.	Severe: slope, rock outcrop.	Severe: slope, rock outcrop.	Year round.	Severe: slope, rock outcrop.	Severe: slope, rock outcrop.	Severe: slope, rock outcrop.
79--- Hettinger	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, winter.	Slight---	Slight---	Slight.
80B--- Longrie	Slight---	Slight---	Moderate: depth to rock.	Year round.	Slight---	Slight---	Moderate: depth to rock.
80D--- Longrie	Slight---	Severe: slope.	Moderate: depth to rock.	Year round.	Slight---	Severe: slope.	Moderate: depth to rock.
82B--- Ubly Variant	Slight---	Slight---	Slight---	Year round.	Slight---	Slight---	Slight.
82D--- Ubly Variant	Slight---	Severe: slope.	Slight---	Year round.	Slight---	Severe: slope.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
10*: Waucedah. Cathro.					
13B, 13D, 13F----- Pemene	Manyflower cotoneaster.	Lilac, nannyberry viburnum, silky dogwood, common ninebark.	Northern white-cedar, white spruce.	Norway spruce, eastern white pine, red pine, green ash.	Imperial Carolina poplar.
14B, 14D---------- Fence	---	Northern white-cedar, lilac, silky dogwood, American cranberrybush, Amur maple, gray dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine, red maple, white ash.	---
15*: Carbondale. Cathro.					
17*: Greenwood. Dawson.					
20B, 20D, 20F----- Karlin	Manyflower cotoneaster.	Siberian crabapple, arrowwood, lilac, Amur privet, Siberian peashrub, Amur maple.	Eastern redcedar	Red pine, eastern white pine, Norway spruce.	Imperial Carolina poplar.
23B, 23D---------- Escanaba	---	Lilac, Amur maple, Siberian peashrub, common ninebark, Roselow sargent crabapple.	Siberian crabapple, white spruce.	Norway spruce, eastern white pine, jack pine, red pine, Norway spruce.	---
24B, 24D, 24F----- Emmet	---	Arrowwood, lilac, nannyberry viburnum, Amur privet.	White spruce, Siberian crabapple, eastern redcedar.	Red pine, Norway spruce, eastern white pine, red maple.	Carolina poplar.
25B, 25D, 25F----- Pence	Manyflower cotoneaster.	Eastern redcedar, lilac, Amur maple, American cranberrybush, Siberian peashrub, silky dogwood, gray dogwood.	Norway spruce-----	Eastern white pine, red pine, jack pine.	---

See footnote at end of table.

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
26---------- Deford	---	Nannyberry viburnum, lilac, silky dogwood, American cranberrybush, common ninebark.	Northern white-cedar, Amur maple.	Eastern white pine, Norway spruce, white spruce, green ash.	Imperial Carolina poplar.
32A---------- Rousseau	Vanhoutte spirea, manyflower cotoneaster.	Siberian crabapple, silky dogwood, Amur privet.	White spruce, eastern redcedar.	Red pine, eastern white pine, jack pine, Norway spruce.	Imperial Carolina poplar.
35B, 35D, 35F----- Nadeau	Manyflower cotoneaster.	Lilac, nannyberry viburnum, silky dogwood, common ninebark.	Northern white-cedar, white spruce.	Norway spruce, eastern white pine, red pine, green ash.	Imperial Carolina poplar.
36B, 36D, 36F----- Rousseau	Vanhoutte spirea, manyflower cotoneaster.	Siberian crabapple, silky dogwood, Amur privet.	White spruce, eastern redcedar.	Red pine, eastern white pine, jack pine, Norway spruce.	Imperial Carolina poplar.
46B, 46D---------- Oconto	Manyflower cotoneaster.	Lilac, Siberian peashrub, eastern redcedar, American cranberrybush, Amur maple, gray dogwood, silky dogwood.	Norway spruce-----	Eastern white pine, red pine, jack pine.	---
47A---------- Wainola	---	White spruce, silky dogwood, Tatarian honeysuckle, American cranberrybush, Amur privet.	Northern white-cedar, Manchurian crabapple.	Norway spruce, eastern white pine, golden willow, Austrian pine.	Imperial Carolina poplar.
49B, 49D, 49F----- Mancelona	---	Amur maple, lilac, eastern redcedar, Siberian peashrub, nannyberry viburnum.	White spruce, Siberian crabapple, northern white-cedar.	Red pine, jack pine, eastern white pine, Norway spruce.	---
50*. Pits					
55. Kinross					
57B, 57D, 57F----- Vilas	Manyflower cotoneaster.	Eastern redcedar, lilac, Amur maple, American cranberrybush, Siberian peashrub, silky dogwood, gray dogwood.	Norway spruce-----	Eastern white pine, red pine, jack pine.	---

See footnote at end of table.

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
59A---------- Channing	---	American cranberrybush, lilac, silky dogwood, Roselow sargent crabapple, nannyberry viburnum, Amur maple.	White spruce, Siberian crabapple.	Norway spruce, eastern white pine, jack pine.	Imperial Carolina poplar.
60B, 60D, 60F----- Zimmerman	Manyflower cotoneaster.	Eastern redcedar, Siberian crabapple, Amur privet, lilac, silky dogwood, Amur maple, Siberian peashrub.	---	Red pine, eastern white pine, jack pine.	---
64B, 64D, 64F----- Rubicon	Manyflower cotoneaster.	Eastern redcedar, Siberian crabapple, Amur privet, lilac, silky dogwood, Amur maple, Siberian peashrub.	---	Red pine, eastern white pine, jack pine.	---
65*. Pits and Dumps					
66D*, 66F*: Zimmerman--------	Manyflower cotoneaster.	Eastern redcedar, Siberian crabapple, Amur privet, lilac, silky dogwood, Amur maple, Siberian peashrub.	---	Red pine, eastern white pine, jack pine.	---
Rock outcrop.					
67. Udorthents					
68D*, 68F*: Pemene----------	Manyflower cotoneaster.	Lilac, nannyberry viburnum, silky dogwood, common ninebark.	Northern white-cedar, white spruce.	Norway spruce, eastern white pine, red pine, green ash.	Imperial Carolina poplar.
Rock outcrop.					
69D*, 69F*: Emmet----------	---	Arrowwood, lilac, nannyberry viburnum, Amur privet.	White spruce, Siberian crabapple, eastern redcedar.	Red pine, Norway spruce, eastern white pine, red maple.	Carolina poplar.
Rock outcrop.					

See footnote at end of table.

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
70B---------- Solona	---	Common ninebark, lilac, silky dogwood, northern white-cedar, American cranberrybush, redosier dogwood, nannyberry viburnum.	White spruce------	Eastern white pine, white ash, silver maple, red maple.	---
71. Ensley					
72*: Aquents.					
Histosols.					
75B---------- Alstad	---	Northern white-cedar, lilac, American cranberrybush, nannyberry viburnum, silky dogwood, redosier dogwood.	White spruce------	Eastern white pine, green ash, white ash, red maple, silver maple.	---
76B*, 76D*: Emmet----------	---	Arrowwood, lilac, nannyberry viburnum, Amur privet.	White spruce, Siberian crabapple, eastern redcedar.	Red pine, Norway spruce, eastern white pine, red maple.	Carolina poplar.
Pemene----------	Manyflower cotoneaster.	Lilac, nannyberry viburnum, silky dogwood, common ninebark.	Northern white-cedar, white spruce.	Norway spruce, eastern white pine, red pine, green ash.	Imperial Carolina poplar.
77D*, 77F*: Rock outcrop.					
Pemene----------	Manyflower cotoneaster.	Lilac, nannyberry viburnum, silky dogwood, common ninebark.	Northern white-cedar, white spruce.	Norway spruce, eastern white pine, red pine, green ash.	Imperial Carolina poplar.
79. Hettinger					
80B, 80D. Longrie					
82B, 82D---------- Ubly Variant	---	Amur maple, lilac, common ninebark, Roselow sargent crabapple, nannyberry viburnum, silky dogwood.	White spruce, Siberian crabapple.	Norway spruce, eastern white pine, jack pine, red pine.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
10*:				
Waucedah	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding, flooding.	Severe: ponding.
Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
13B Pemene	Slight	Slight	Moderate: slope, small stones.	Slight.
13D Pemene	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
13F Pemene	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
14B Fence	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight.
14D Fence	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Severe: erodes easily.
15*:				
Carbondale	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
17*:				
Greenwood	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
Dawson	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
20B Karlin	Slight	Slight	Moderate: slope, small stones.	Slight.
20D Karlin	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
20F Karlin	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
23B--Escanaba	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
23D--Escanaba	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
24B--Emmet	Slight	Slight	Moderate: slope.	Slight.
24D--Emmet	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
24F--Emmet	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
25B--Pence	Slight	Slight	Moderate: slope, small stones.	Slight.
25D--Pence	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
25F--Pence	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
26--Deford	Severe: ponding.	Severe: ponding, too sandy.	Severe: too sandy, ponding.	Severe: ponding, too sandy.
32A--Rousseau	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
35B--Nadeau	Slight	Slight	Moderate: slope, small stones.	Slight.
35D--Nadeau	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
35F--Nadeau	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
36B--Rousseau	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
36D--Rousseau	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
36F--Rousseau	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.
46B--Oconto	Slight	Slight	Moderate: slope, small stones.	Slight.
46D--Oconto	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
47A---------- Wainola	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.
49B---------- Mancelona	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight.
49D---------- Mancelona	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Slight.
49F---------- Mancelona	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.
50*. Pits				
55---------- Kinross	Severe: ponding, too sandy.	Severe: ponding, too sandy.	Severe: too sandy, ponding.	Severe: ponding, too sandy.
57B---------- Vilas	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, small stones, too sandy.	Moderate: too sandy.
57D---------- Vilas	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
57F---------- Vilas	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
59A---------- Channing	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
60B---------- Zimmerman	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
60D---------- Zimmerman	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
60F---------- Zimmerman	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.
64B---------- Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
64D---------- Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
64F---------- Rubicon	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.
65*. Pits and Dumps				

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
66D*: Zimmerman	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Rock outcrop.				
66F*: Zimmerman	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.
Rock outcrop.				
67. Udorthents				
68D*: Pemene	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Rock outcrop.				
68F*: Pemene	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.				
69D*: Emmet	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Rock outcrop.				
69F*: Emmet	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.				
70B--Solona	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
71--Ensley	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
72*: Aquents.				
Histosols.				
75B--Alstad	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
76B*: Emmet	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
76B*: Pemene	Slight	Slight	Moderate: slope, small stones.	Slight.
76D*: Emmet	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Pemene	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
77D*: Rock outcrop.				
Pemene	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
77F*: Rock outcrop.				
Pemene	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
79 Hettinger	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
80B Longrie	Slight	Slight	Moderate: slope, small stones.	Slight.
80D Longrie	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
82B Ubly Variant	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight.
82D Ubly Variant	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
10*:										
Waucedah	Very poor.	Poor	Poor	Fair	Fair	Good	Fair	Poor	Fair	Fair.
Cathro	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
13B---------- Pemene	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
13D---------- Pemene	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
13F---------- Pemene	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
14B---------- Fence	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
14D---------- Fence	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
15*:										
Carbondale	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Cathro	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
17*:										
Greenwood	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Dawson	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
20B, 20D---------- Karlin	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
20F---------- Karlin	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
23B---------- Escanaba	Poor	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
23D---------- Escanaba	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
24B---------- Emmet	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
24D---------- Emmet	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
24F---------- Emmet	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
25B---------- Pence	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
25D, 25F---------- Pence	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
26---------- Deford	Poor	Poor	Poor	Poor	Poor	Fair	Good	Poor	Poor	Fair.
32A---------- Rousseau	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Poor.
35B, 35D---------- Nadeau	Fair	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
35F---------- Nadeau	Very poor.	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
36B---------- Rousseau	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
36D---------- Rousseau	Fair	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
36F---------- Rousseau	Very poor.	Poor	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
46B---------- Oconto	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
46D---------- Oconto	Poor	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
47A---------- Wainola	Fair	Fair	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
49B, 49D---------- Mancelona	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
49F---------- Mancelona	Very poor.	Poor	Good	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
50*. Pits										
55---------- Kinross	Very poor.	Poor	Poor	Fair	Fair	Good	Good	Very poor.	Fair	Good.
57B---------- Vilas	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
57D, 57F---------- Vilas	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
59A---------- Channing	Fair	Good	Good	Fair	Fair	Fair	Fair	Good	Fair	Fair.
60B---------- Zimmerman	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Poor.
60D, 60F---------- Zimmerman	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
64B---------- Rubicon	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
64D---------- Rubicon	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
64F---------- Rubicon	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
65*. Pits and Dumps										
66D*, 66F*: Zimmerman---------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Rock outcrop.										
67. Udorthents										
68D*: Pemene----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Rock outcrop.										
68F*: Pemene----------	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
Rock outcrop.										
69D*: Emmet----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Rock outcrop.										
69F*: Emmet----------	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Rock outcrop.										
70B---------- Solona	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
71---------- Ensley	Good	Good	Poor	Poor	Poor	Good	Good	Good	Poor	Good.
72*: Aquents.										
Histosols.										
75B---------- Alstad	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
76B*:										
Emmet	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Pemene	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
76D*:										
Emmet	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Pemene	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
77D*:										
Rock outcrop.										
Pemene	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
77F*:										
Rock outcrop.										
Pemene	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
79 Hettinger	Good	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
80B Longrie	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
80D Longrie	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
82B, 82D Ubly Variant	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
10*: Waucedah	Severe: ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: ponding, flooding, frost action.	Severe: ponding, flooding.
Cathro	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
13B Pemene	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.	Moderate: large stones, droughty.
13D Pemene	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, droughty, slope.
13F Pemene	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
14B Fence	Severe: cutbanks cave.	Slight	Slight	Slight	Severe: frost action.	Slight.
14D Fence	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
15*: Carbondale	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
Cathro	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
17*: Greenwood	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
Dawson	Severe: cutbanks cave, excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
20B Karlin	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.

See footnote at end of table.

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
20D---------- Karlin	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
20F---------- Karlin	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
23B---------- Escanaba	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Moderate: large stones.
23D---------- Escanaba	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
24B---------- Emmet	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
24D---------- Emmet	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
24F---------- Emmet	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
25B---------- Pence	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: large stones, droughty.
25D---------- Pence	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: large stones, droughty, slope.
25F---------- Pence	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
26---------- Deford	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
32A---------- Rousseau	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Slight---------	Moderate: droughty.
35B---------- Nadeau	Severe: cutbanks cave.	Moderate: large stones.	Moderate: large stones.	Moderate: large stones.	Moderate: large stones.	Moderate: droughty.
35D---------- Nadeau	Severe: cutbanks cave.	Moderate: slope, large stones.	Moderate: slope, large stones.	Severe: slope.	Moderate: slope, large stones.	Moderate: droughty, slope.
35F---------- Nadeau	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
36B---------- Rousseau	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.

See footnote at end of table.

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
36D--- Rousseau	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
36F--- Rousseau	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
46B--- Oconto	Severe: cutbanks cave.	Slight---	Slight---	Moderate: slope.	Moderate: frost action.	Moderate: droughty.
46D--- Oconto	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: droughty, slope.
47A--- Wainola	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
49B--- Mancelona	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight---	Moderate: small stones, droughty.
49D--- Mancelona	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones, droughty, slope.
49F--- Mancelona	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
50*. Pits						
55--- Kinross	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, droughty.
57B--- Vilas	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight---	Moderate: droughty.
57D--- Vilas	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
57F--- Vilas	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
59A--- Channing	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
60B--- Zimmerman	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight---	Moderate: droughty.
60D--- Zimmerman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.

See footnote at end of table.

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
60F---------- Zimmerman	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
64B---------- Rubicon	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Severe: droughty.
64D---------- Rubicon	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
64F---------- Rubicon	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
65*. Pits and Dumps						
66D*: Zimmerman--------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Rock outcrop.						
66F*: Zimmerman--------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.						
67. Udorthents						
68D*: Pemene----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, droughty, slope.
Rock outcrop.						
68F*: Pemene----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.						
69D*: Emmet----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Rock outcrop.						
69F*: Emmet----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
69F*: Rock outcrop.						
70B---------- Solona	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness, droughty.
71---------- Ensley	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
72*: Aquents.						
Histosols.						
75B---------- Alstad	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
76B*: Emmet----------	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
Pemene----------	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Moderate: large stones, droughty.
76D*: Emmet----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Pemene----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, droughty, slope.
77D*: Rock outcrop.						
Pemene----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, droughty, slope.
77F*: Rock outcrop.						
Pemene----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
79---------- Hettinger	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
80B---------- Longrie	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock, frost action.	Moderate: large stones, droughty.

See footnote at end of table.

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
80D---------- Longrie	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope, frost action.	Moderate: large stones, droughty, slope.
82B---------- Ubly Variant	Moderate: dense layer.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: frost action.	Slight.
82D---------- Ubly Variant	Moderate: dense layer, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: frost action.	Moderate: slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
10*:					
Waucedah	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Poor: ponding.
Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
13B Pemene	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
13D Pemene	Moderate: percs slowly, slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
13F Pemene	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: seepage, slope.
14B Fence	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Good.
14D Fence	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
15*:					
Carbondale	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
17*:					
Greenwood	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
Dawson	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
20B Karlin	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnote at end of table.

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
20D---------- Karlin	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
20F---------- Karlin	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
23B---------- Escanaba	Moderate: percs slowly.	Severe: seepage.	Slight----------	Severe: seepage.	Fair: small stones.
23D---------- Escanaba	Moderate: percs slowly, slope.	Severe: seepage, slope.	Moderate: slope.	Severe: seepage.	Fair: small stones, slope.
24B---------- Emmet	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
24D---------- Emmet	Moderate: percs slowly, slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
24F---------- Emmet	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
25B---------- Pence	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
25D---------- Pence	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
25F---------- Pence	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
26---------- Deford	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: too sandy, ponding.
32A---------- Rousseau	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
35B---------- Nadeau	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
35D---------- Nadeau	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
35F---------- Nadeau	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
36B---------- Rousseau	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
36D---------- Rousseau	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
36F---------- Rousseau	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
46B---------- Oconto	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
46D---------- Oconto	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
47A---------- Wainola	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
49B---------- Mancelona	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
49D---------- Mancelona	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
49F---------- Mancelona	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
50*. Pits					
55---------- Kinross	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
57B---------- Vilas	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnote at end of table.

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
57D---------- Vilas	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
57F---------- Vilas	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
59A---------- Channing	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
60B---------- Zimmerman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
60D---------- Zimmerman	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
60F---------- Zimmerman	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
64B---------- Rubicon	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
64D---------- Rubicon	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
64F---------- Rubicon	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
65*. Pits and Dumps					
66D*: Zimmerman----------	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Rock outcrop.					
66F*: Zimmerman----------	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Rock outcrop.					
67. Udorthents					

See footnote at end of table.

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
68D*:					
Pemene	Moderate: percs slowly, slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
Rock outcrop.					
68F*:					
Pemene	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: seepage, slope.
Rock outcrop.					
69D*:					
Emmet	Moderate: percs slowly, slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
Rock outcrop.					
69F*:					
Emmet	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Rock outcrop.					
70B--- Solona	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
71--- Ensley	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding.
72*:					
Aquents.					
Histosols.					
75B--- Alstad	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
76B*:					
Emmet	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Pemene	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
76D*:					
Emmet	Moderate: percs slowly, slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
Pemene	Moderate: percs slowly, slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.

See footnote at end of table.

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
77D*: Rock outcrop.					
Pemene	Moderate: percs slowly, slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
77F*: Rock outcrop.					
Pemene	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: seepage, slope.
79 Hettinger	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
80B Longrie	Severe: thin layer, seepage.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
80D Longrie	Severe: thin layer, seepage.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Moderate: seepage, slope.	Poor: area reclaim, thin layer.
82B Ubly Variant	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
82D Ubly Variant	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
10*: Waucedah	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, wetness.
Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
13B, 13D Pemene	Good	Probable	Improbable: too sandy.	Poor: small stones.
13F Pemene	Poor: slope.	Probable	Improbable: too sandy.	Poor: small stones, slope.
14B Fence	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
14D Fence	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
15*: Carbondale	Poor: wetness.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
17*: Greenwood	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
Dawson	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
20B Karlin	Good	Probable	Improbable: too sandy.	Fair: too sandy, small stones.
20D Karlin	Good	Probable	Improbable: too sandy.	Fair: too sandy, small stones.
20F Karlin	Poor: slope.	Probable	Improbable: too sandy.	Poor: slope.
23B, 23D Escanaba	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, large stones.

See footnote at end of table.

TABLE 15.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
24B---- Emmet	Good----	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
24D---- Emmet	Good----	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, slope.
24F---- Emmet	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
25B, 25D---- Pence	Good----	Probable----	Probable----	Poor: small stones, area reclaim.
25F---- Pence	Poor: slope.	Probable----	Probable----	Poor: small stones, area reclaim, slope.
26---- Deford	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, wetness.
32A---- Rousseau	Fair: wetness.	Probable----	Improbable: too sandy.	Poor: too sandy.
35B, 35D---- Nadeau	Fair: large stones.	Probable----	Probable----	Poor: too sandy, small stones, area reclaim.
35F---- Nadeau	Poor: slope.	Probable----	Probable----	Poor: too sandy, small stones, area reclaim.
36B, 36D---- Rousseau	Good----	Probable----	Improbable: too sandy.	Poor: too sandy.
36F---- Rousseau	Poor: slope.	Probable----	Improbable: too sandy.	Poor: too sandy, slope.
46B, 46D---- Oconto	Good----	Probable----	Probable----	Poor: small stones, area reclaim.
47A---- Wainola	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, wetness.
49B, 49D---- Mancelona	Good----	Probable----	Probable----	Poor: small stones, area reclaim.
49F---- Mancelona	Poor: slope.	Probable----	Probable----	Poor: small stones, area reclaim, slope.

See footnote at end of table.

TABLE 15.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
50*. Pits				
55---------- Kinross	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy, wetness.
57B, 57D---------- Vilas	Good----------	Probable----------	Improbable: too sandy.	Poor: too sandy.
57F---------- Vilas	Poor: slope.	Probable----------	Improbable: too sandy.	Poor: too sandy, slope.
59A---------- Channing	Poor: wetness.	Probable----------	Probable----------	Poor: small stones, area reclaim, wetness.
60B, 60D---------- Zimmerman	Good----------	Probable----------	Improbable: too sandy.	Poor: too sandy.
60F---------- Zimmerman	Fair: slope.	Probable----------	Improbable: too sandy.	Poor: too sandy, slope.
64B, 64D---------- Rubicon	Good----------	Probable----------	Improbable: too sandy.	Poor: too sandy.
64F---------- Rubicon	Poor: slope.	Probable----------	Improbable: too sandy.	Poor: too sandy, slope.
65*. Pits and Dumps				
66D*: Zimmerman---------- Rock outcrop.	Good----------	Probable----------	Improbable: too sandy.	Fair: too sandy, slope.
66F*: Zimmerman---------- Rock outcrop.	Fair: slope.	Probable----------	Improbable: too sandy.	Poor: too sandy, slope.
67. Udorthents				
68D*: Pemene---------- Rock outcrop.	Good----------	Probable----------	Improbable: too sandy.	Poor: small stones.

See footnote at end of table.

TABLE 15.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
68F*: Pemene	Poor: slope.	Probable	Improbable: too sandy.	Poor: small stones, slope.
Rock outcrop.				
69D*: Emmet	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, slope.
Rock outcrop.				
69F*: Emmet	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Rock outcrop.				
70B Solona	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
71 Ensley	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
72*: Aquents.				
Histosols.				
75B Alstad	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
76B*: Emmet	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
Pemene	Good	Probable	Improbable: too sandy.	Poor: small stones.
76D*: Emmet	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, slope.
Pemene	Good	Probable	Improbable: too sandy.	Poor: small stones.
77D*: Rock outcrop.				
Pemene	Good	Probable	Improbable: too sandy.	Poor: small stones.
77F*: Rock outcrop.				

See footnote at end of table.

TABLE 15.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
77F*: Pemene	Poor: slope.	Probable	Improbable: too sandy.	Poor: small stones, slope.
79 Hettinger	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
80B, 80D Longrie	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
82B Ubly Variant	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones.
82D Ubly Variant	Fair: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, slope.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
10*:						
Waucedah	Moderate: seepage.	Severe: piping, ponding.	Severe: slow refill.	Ponding, flooding, frost action.	Ponding, soil blowing, rooting depth.	Wetness, rooting depth.
Cathro	Severe: seepage.	Severe: piping, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
13B---------- Pemene	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty.	Droughty.
13D, 13F---------- Pemene	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty.	Slope, droughty.
14B---------- Fence	Moderate: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing, erodes easily.	Erodes easily.
14D---------- Fence	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing, erodes easily.	Slope, erodes easily.
15*:						
Carbondale	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
Cathro	Severe: seepage.	Severe: piping, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
17*:						
Greenwood	Severe: seepage.	Severe: excess humus, ponding.	Moderate: slow refill.	Ponding, frost action.	Ponding	Wetness.
Dawson	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill, cutbanks cave.	Ponding, subsides, frost action.	Ponding	Wetness.
20B---------- Karlin	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, soil blowing.	Droughty.
20D, 20F---------- Karlin	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, soil blowing.	Slope, droughty.
23B---------- Escanaba	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Slope, fast intake, soil blowing.	Large stones.

See footnote at end of table.

TABLE 16.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
23D---------- Escanaba	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, fast intake, soil blowing.	Large stones, slope.
24B---------- Emmet	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Rooting depth, slope.	Rooting depth.
24D, 24F---------- Emmet	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Rooting depth, slope.	Slope, rooting depth.
25B---------- Pence	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, soil blowing, slope.	Droughty.
25D, 25F---------- Pence	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, soil blowing, slope.	Slope, droughty.
26---------- Deford	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Wetness, droughty.
32A---------- Rousseau	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty.	Droughty.
35B---------- Nadeau	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Slope, large stones, droughty.	Large stones, droughty.
35D, 35F---------- Nadeau	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, large stones, droughty.	Large stones, slope, droughty.
36B---------- Rousseau	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
36D, 36F---------- Rousseau	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
46B---------- Oconto	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, soil blowing.	Droughty.
46D---------- Oconto	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, soil blowing.	Slope, droughty.
47A---------- Wainola	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty.	Wetness, droughty.
49B---------- Mancelona	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.

See footnote at end of table.

TABLE 16.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
49D, 49F---------- Mancelona	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
50*. Pits						
55---------- Kinross	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Wetness, droughty.
57B---------- Vilas	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
57D, 57F---------- Vilas	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
59A---------- Channing	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, droughty, soil blowing.	Wetness, droughty.
60B---------- Zimmerman	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
60D, 60F---------- Zimmerman	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
64B---------- Rubicon	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
64D, 64F---------- Rubicon	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
65*. Pits and Dumps						
66D*, 66F*: Zimmerman-------- Rock outcrop.	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
67. Udorthents						
68D*, 68F*: Pemene---------- Rock outcrop.	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty.	Slope, droughty.

See footnote at end of table.

TABLE 16.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
69D*, 69F*: Emmet	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Rooting depth, slope.	Slope, rooting depth.
Rock outcrop.						
70B--- Solona	Moderate: seepage.	Severe: piping, wetness.	Moderate: slow refill.	Frost action---	Wetness, droughty, soil blowing.	Wetness, droughty.
71--- Ensley	Severe: seepage.	Severe: piping, ponding.	Moderate: slow refill.	Ponding, frost action.	Ponding, droughty, soil blowing.	Wetness, droughty.
72*: Aquents.						
Histosols.						
75B--- Alstad	Moderate: seepage, slope.	Severe: thin layer.	Severe: no water.	Frost action, slope.	Wetness, slope.	Wetness, erodes easily.
76B*: Emmet	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Rooting depth, slope.	Rooting depth.
Pemene	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty.	Droughty.
76D*: Emmet	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Rooting depth, slope.	Slope, rooting depth.
Pemene	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty.	Slope, droughty.
77D*, 77F*: Rock outcrop.						
Pemene	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty.	Slope, droughty.
79--- Hettinger	Slight---	Severe: piping, hard to pack, ponding.	Severe: no water.	Ponding, percs slowly, frost action.	Ponding, percs slowly, rooting depth.	Wetness, erodes easily, rooting depth.
80B--- Longrie	Moderate: seepage, depth to rock, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, droughty, soil blowing.	Large stones, droughty.
80D--- Longrie	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, droughty, soil blowing.	Large stones, slope, droughty.

See footnote at end of table.

TABLE 16.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
82B---------- Ubly Variant	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing, percs slowly.	Rooting depth, percs slowly.
82D---------- Ubly Variant	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing, percs slowly.	Slope, rooting depth, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
10*:											
Waucedah--------	0-11	Mucky sandy loam	SM, SM-SC, ML, CL-ML	A-2-4, A-4	0	100	100	70-95	30-75	<25	NP-7
	11-60	Loam, fine sandy loam, sandy loam.	SM, SM-SC, SC, CL-ML	A-2-4, A-4	0	100	100	70-95	30-75	<25	3-8
Cathro----------	0-8	Muck----------	PT	A-8	0	---	---	---	---	---	---
	8-43	Sapric material, muck.	PT	A-8	0	---	---	---	---	---	---
	43-60	Sandy loam, very fine sandy loam, clay loam.	SM, ML, SC, CL	A-4, A-6	0-5	80-100	65-100	60-100	35-90	15-40	3-25
13B, 13D, 13F---- Pemene	0-27	Fine sandy loam	SM-SC, SM	A-2-4, A-4	0-15	95-100	85-100	60-85	20-50	<25	NP-7
	27-60	Sandy loam, fine sandy loam, loamy fine sand.	SC, SM, ML, CL	A-2-4, A-4	0-15	95-100	85-100	60-85	25-55	<30	NP-10
14B, 14D--------- Fence	0-8	Very fine sandy loam.	ML, CL-ML	A-4	0	100	100	85-95	50-65	<25	NP-7
	8-48	Silt loam, very fine sandy loam, silt.	ML, CL-ML, CL	A-4, A-6	0	100	100	85-100	70-100	<30	NP-12
	48-60	Stratified silt loam to very fine sand.	ML, CL-ML	A-4	0	100	100	85-100	50-100	<25	NP-7
15*:											
Carbondale------	0-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
Cathro----------	0-8	Sapric material	PT	A-8	0	---	---	---	---	---	---
	8-43	Sapric material, muck.	PT	A-8	0	---	---	---	---	---	---
	43-60	Sandy loam, very fine sandy loam, clay loam.	SM, ML, SC, CL	A-4, A-6	0-5	80-100	65-100	60-100	35-90	15-40	3-25
17*:											
Greenwood-------	0-6	Fibric material	PT	A-8	0	---	---	---	---	---	---
	6-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
Dawson----------	0-13	Fibric material	PT	A-8	---	---	---	---	---	---	---
	13-30	Sapric material	PT	A-8	---	---	---	---	---	---	---
	30-60	Sand, loamy fine sand, very fine sand.	SM-SC, SM, SC, SP-SM	A-2, A-3, A-1	0	90-100	50-100	25-90	0-30	<20	NP-10
20B, 20D, 20F---- Karlin	0-31	Loamy fine sand	SM	A-2	0	90-100	85-100	50-95	15-35	---	NP-4
	31-60	Sand----------	SP-SM, SP, SM	A-3, A-1, A-2	0	80-100	70-100	40-95	0-25	---	NP

See footnote at end of table.

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
23B, 23D--------- Escanaba	0-6	Loamy fine sand	SM, SM-SC, SW-SM, SP-SM	A-2-4, A-3, A-1-b	0-5	95-100	85-100	40-75	5-30	<25	NP-7
	6-21	Loamy fine sand, fine sand, sand.	SM, SM-SC, SW-SM, SP-SM	A-2-4, A-3, A-1-b	0-5	90-100	85-100	40-75	5-30	<25	NP-7
	21-34	Loamy fine sand, loamy sand, fine sandy loam.	SM, SM-SC, ML, CL-ML	A-2-4, A-4	0-5	90-100	85-100	50-85	15-55	<25	NP-7
	34-46	Fine sandy loam, sandy loam.	SC, SM-SC, CL, CL-ML	A-2-4, A-4	0-5	90-100	85-100	50-85	25-55	<30	4-10
	46-60	Fine sandy loam, sandy loam, gravelly sandy loam.	SM, SC, ML, CL	A-2-4, A-4	0-20	80-95	75-95	50-85	20-55	<30	NP-10
24B, 24D, 24F---- Emmet	0-4	Fine sandy loam	SM, SM-SC, SC, ML	A-2, A-1-b, A-4	0-5	95-100	75-100	45-75	20-60	<25	NP-10
	4-16	Sandy loam, loamy sand, fine sandy loam.	SM, SC, ML, CL	A-2	0-5	95-100	75-100	35-70	10-55	<25	NP-10
	16-33	Loam, sandy loam, fine sandy loam.	SM-SC, CL, CL-ML, SC	A-2, A-4, A-6, A-1-b	0-5	95-100	90-100	45-95	20-75	20-40	5-20
	33-60	Sandy loam, fine sandy loam, gravelly fine sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1-b	0-5	85-95	65-95	45-80	20-50	<25	NP-10
25B, 25D, 25F---- Pence	0-4	Fine sandy loam	SM, ML	A-4, A-2, A-1	0-7	85-100	75-100	45-85	20-55	<21	NP-4
	4-16	Sandy loam, loam, gravelly sandy loam.	SM, ML, CL-ML, SM-SC	A-4, A-2, A-1	0-7	55-100	50-100	30-95	15-75	<25	NP-7
	16-27	Gravelly coarse sand, loamy sand, sand.	SM, SP-SM, GM, GP-GM	A-2, A-1	0-8	55-100	50-100	25-75	10-30	---	NP
	27-60	Gravelly loamy sand, sand, sand and gravel.	SP, SM, GP, GM	A-1, A-3, A-2	0-15	50-100	50-100	25-70	2-20	---	NP
26--------------- Deford	0-6	Fine sand--------	SM	A-2-4	0	100	95-100	65-80	20-35	---	NP
	6-60	Fine sand, very fine sand, loamy fine sand.	SM	A-2-4	0	100	95-100	50-80	15-35	---	NP
32A-------------- Rousseau	0-6	Fine sand--------	SP-SM, SM	A-2-4, A-3	0	100	100	90-100	5-35	---	NP
	6-31	Fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2-4	0	100	100	90-100	5-35	---	NP
	31-60	Fine sand, sand	SP, SP-SM, SM	A-3, A-2-4	0	100	100	85-100	0-15	---	NP

See footnote at end of table.

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
35B, 35D, 35F---- Nadeau	0-25	Fine sandy loam	SM, SC, ML, CL	A-2-4, A-4	0-5	85-100	80-100	55-95	25-70	<30	NP-10
	25-30	Very gravelly sandy loam, very gravelly loam, very gravelly fine sandy loam.	GM, GC, GP-GM, GM-GC	A-1, A-2-4, A-4	5-40	40-65	30-55	15-50	10-50	20-30	3-10
	30-60	Very gravelly coarse sand, very gravelly sand.	GW, GW, SW, SW-SM	A-1	5-40	40-75	30-65	10-35	0-10	---	NP
36B, 36D, 36F---- Rousseau	0-6	Fine sand--------	SP-SM, SM	A-2-4, A-3	0	100	100	90-100	5-35	---	NP
	6-31	Fine sand--------	SP-SM, SM	A-3, A-2-4	0	100	100	90-100	5-25	---	NP
	31-60	Fine sand, sand	SP, SP-SM	A-3	0	100	100	85-100	0-10	---	NP
46B, 46D--------- Oconto	0-3	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-2, A-4	0	80-100	75-100	45-85	25-55	<23	2-7
	3-27	Fine sandy loam, sandy loam, loam.	ML, CL, SM, SC	A-2, A-4	0	80-100	75-100	45-95	25-75	<28	3-9
	27-60	Sand, gravelly sand, loamy sand.	SP, SP-SM, GP, GP-GM	A-1, A-2, A-3	0-3	45-100	40-95	20-65	2-12	---	NP
47A---------- Wainola	0-4	Fine sand--------	SM	A-2-4	0	100	90-100	65-80	20-35	---	NP
	4-37	Fine sand, loamy fine sand, very fine sand.	SM	A-2-4	0	100	90-100	50-80	15-35	---	NP
	37-60	Fine sand, loamy fine sand, very fine sand.	SM	A-2-4	0	100	90-100	50-80	15-35	---	NP
49B, 49D, 49F---- Mancelona	0-3	Loamy sand-------	SM, ML	A-2, A-1-b, A-4	0-5	90-100	65-95	40-90	15-55	---	NP
	3-26	Loamy sand, sand, gravelly loamy sand.	SM, SP-SM	A-2, A-1-b	0-5	90-100	65-95	40-80	10-30	---	NP
	26-31	Gravelly loamy sand, sandy clay loam, gravelly sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	85-100	60-95	50-70	15-45	12-30	NP-10
	31-60	Very gravelly sand, gravelly sand, coarse sand.	GP, SP, GW, SW	A-1	5-10	40-90	35-85	20-40	0-10	---	NP
50*. Pits											
55---------- Kinross	0-9	Mucky fine sand	SP-SM, SM, SP	A-3, A-2-4	0	100	100	50-95	0-25	---	NP
	9-60	Sand, fine sand	SP-SM, SM, SP	A-3, A-2-4	0	100	95-100	50-95	0-25	---	NP

See footnote at end of table.

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
57B, 57D, 57F---- Vilas	0-3	Loamy sand-------	SM, SP-SM	A-1, A-2	0	80-100	75-100	35-90	12-30	---	NP
	3-17	Loamy sand-------	SP-SM, SM	A-1, A-2	0	80-100	75-100	35-90	12-30	---	NP
	17-34	Sand-------------	SM, SP-SM	A-1, A-2, A-3	0	80-100	75-100	35-90	5-20	---	NP
	34-60	Sand-------------	SP, SP-SM, SM	A-1, A-2, A-3	0	80-100	75-100	35-90	1-20	---	NP
59A---------- Channing	0-5	Fine sandy loam	SM, ML, CL-ML, SM-SC	A-2-4, A-4	0-20	95-100	95-100	55-95	25-65	<25	NP-6
	5-23	Very fine sandy loam, fine sandy loam, loam.	SM, ML, CL-ML, SM-SC	A-2-4, A-4	0-5	95-100	95-100	55-95	25-75	<25	NP-7
	23-60	Stratified sand to very gravelly sand.	SP, SP-SM	A-1	0-10	65-95	40-80	20-30	0-10	---	NP
60B, 60D, 60F---- Zimmerman	0-3	Fine sand--------	SM, SP-SM	A-2	0	100	100	95-100	10-25	<20	NP
	3-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	5-20	<20	NP
64B, 64D, 64F---- Rubicon	0-5	Sand-------------	SM, SP-SM, SP	A-2, A-3	0	95-100	90-100	50-90	0-25	---	NP
	5-41	Sand-------------	SM, SP-SM, SP	A-2, A-3	0	95-100	90-100	50-90	0-25	---	NP
	41-60	Sand, coarse sand	SP, SP-SM, SM	A-1, A-2, A-3	0	95-100	90-100	40-90	0-25	---	NP
65*. Pits and Dumps											
66D*: Zimmerman-------	0-3	Loamy fine sand	SM	A-2	0	100	100	95-100	15-30	<20	NP
	3-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	5-20	<20	NP
Rock outcrop.											
66F*: Zimmerman-------	0-3	Fine sand--------	SM, SP-SM	A-2	0	100	100	95-100	10-25	<20	NP
	3-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	5-20	<20	NP
Rock outcrop.											
67. Udorthents											
68D*, 68F*: Pemene----------	0-27	Fine sandy loam	SM-SC, SM	A-2-4, A-4	0-15	95-100	85-100	60-85	20-50	<25	NP-7
	27-60	Sandy loam, fine sandy loam.	SC, SM, ML, CL	A-2-4, A-4	0-15	95-100	85-100	60-85	25-55	<30	NP-10
Rock outcrop.											

See footnote at end of table.

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
69D*, 69F*:											
Emmet----------	0-4	Fine sandy loam	SM, SM-SC, SC, ML	A-2, A-1-b, A-4	0-5	95-100	75-100	45-75	20-60	<25	NP-10
	4-16	Sandy loam, loamy sand, fine sandy loam.	SM, SC, ML, CL	A-2	0-5	95-100	75-100	35-70	10-55	<25	NP-10
	16-33	Loam, sandy loam, fine sandy loam.	SM-SC, CL, CL-ML, SC	A-2, A-4, A-6, A-1-b	0-5	95-100	90-100	45-95	20-75	20-40	5-20
	33-60	Sandy loam, fine sandy loam, gravelly fine sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1-b	0-5	85-95	65-95	45-80	20-50	<25	NP-10
Rock outcrop.											
70B----------	0-10	Fine sandy loam	SM, SM-SC	A-4, A-2	0-3	80-100	75-100	45-85	25-50	<20	2-7
Solona	10-23	Fine sandy loam, sandy loam, loam.	CL, ML, SC, SM	A-2, A-4	0-3	80-100	75-100	45-100	25-80	20-30	3-10
	23-60	Loam, fine sandy loam, gravelly sandy loam.	ML, CL, SM, SC	A-2, A-4, A-1	0-3	75-100	60-100	35-95	20-65	<25	NP-10
71----------	0-9	Fine sandy loam	SM-SC, SM	A-2, A-4	0-10	90-100	85-100	50-75	25-40	<25	NP-6
Ensley	9-20	Sandy loam, sandy clay loam, fine sandy loam.	SC, SM-SC	A-6, A-4, A-2	0-10	85-100	85-100	55-95	25-50	20-30	6-16
	20-60	Sandy loam, fine sandy loam.	SM-SC, SM	A-2, A-4	0-10	70-95	70-95	50-75	20-40	<20	NP-7
72*:											
Aquents.											
Histosols.											
75B----------	0-4	Loam----------	CL, CL-ML, ML	A-4	0	95-100	95-100	80-100	55-100	<28	3-9
Alstad	4-21	Fine sandy loam, loam, sandy loam.	ML, CL, SM, SC	A-2, A-4	0	95-100	95-100	55-100	25-100	<26	2-8
	21-42	Clay loam, loam	CL	A-6, A-4, A-2, A-7	0	80-100	75-100	60-100	25-80	20-45	9-28
	42-60	Loam, clay loam, sandy loam.	SC, CL, SM, ML	A-6, A-4, A-2, A-1	0-3	80-100	75-100	45-95	20-75	<35	2-20
76B*, 76D*:											
Emmet----------	0-4	Fine sandy loam	SM, SM-SC, SC, ML	A-2, A-1-b, A-4	0-5	95-100	75-100	45-75	20-60	<25	NP-10
	4-16	Sandy loam, loamy sand, fine sandy loam.	SM, SC, ML, CL	A-2	0-5	95-100	75-100	35-70	10-55	<25	NP-10
	16-33	Loam, sandy loam, fine sandy loam.	SM-SC, CL, CL-ML, SC	A-2, A-4, A-6, A-1-b	0-5	95-100	90-100	45-95	20-75	20-40	5-20
	33-60	Sandy loam, fine sandy loam, gravelly fine sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1-b	0-5	85-95	65-95	45-80	20-50	<25	NP-10

See footnote at end of table.

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
76B*, 76D*: Pemene----------	0-27	Fine sandy loam	SM-SC, SM	A-2-4, A-4	0-15	95-100	85-100	60-85	20-50	<25	NP-7
	27-60	Sandy loam, fine sandy loam.	SC, SM, ML, CL	A-2-4, A-4	0-15	95-100	85-100	60-85	25-55	<30	NP-10
77D*, 77F*: Rock outcrop.											
Pemene----------	0-27	Fine sandy loam	SM-SC, SM	A-2-4, A-4	0-15	95-100	85-100	60-85	20-50	<25	NP-7
	27-60	Sandy loam, fine sandy loam.	SC, SM, ML, CL	A-2-4, A-4	0-15	95-100	85-100	60-85	25-55	<30	NP-10
79---------- Hettinger	0-6	Silt loam--------	ML, CL-ML, CL	A-4	0	100	100	85-100	60-90	20-30	2-10
	6-14	Silty clay loam, silt loam.	CL	A-6	0	100	100	90-100	75-95	25-40	10-25
	14-26	Stratified silt to clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
	26-60	Stratified silt to clay.	CL, ML, CH, MH	A-4, A-6, A-7	0	100	100	85-100	70-95	30-60	5-35
80B, 80D--------- Longrie	0-5	Fine sandy loam	SM, ML, CL, SC	A-2-4, A-4	0-20	90-95	85-95	50-95	25-55	<25	NP-10
	5-21	Loam, sandy loam, silt loam.	SM, ML, CL, SC	A-2-4, A-4	0-20	90-95	85-95	50-95	25-75	<25	2-10
	21	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
82B, 82D--------- Ubly Variant	0-23	Very fine sandy loam.	SM, SM-SC, ML, CL-ML	A-4	0-5	95-100	90-100	65-90	35-60	10-25	NP-10
	23-60	Clay loam--------	CL, ML	A-6, A-4, A-7	5-10	90-100	85-95	75-85	55-70	30-50	5-20

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
10*:											
Waucedah--------	0-11	3-15	0.30-0.50	0.2-6.0	0.25-0.40	6.1-7.3	Low----------	0.20	5	2	12-30
	11-60	6-18	1.80-2.00	0.6-2.0	0.11-0.19	6.1-8.4	Low----------	0.32			
Cathro----------	0-8	---	0.28-0.45	0.2-6.0	0.45-0.55	5.6-7.8	----------	----	2	2	60-85
	8-43	---	0.15-0.30	0.2-6.0	0.35-0.45	5.6-7.8	----------	----			
	43-60	10-30	1.50-1.70	0.2-2.0	0.11-0.22	6.6-8.4	Low----------	----			
13B, 13D, 13F----	0-27	3-15	1.15-1.60	2.0-6.0	0.11-0.17	4.5-6.5	Low----------	0.24	5	3	.5-3
Pemene	27-60	8-20	1.30-1.60	0.6-6.0	0.10-0.16	5.6-7.8	Low----------	0.24			
14B, 14D---------	0-8	5-15	1.20-1.35	0.6-2.0	0.20-0.22	3.6-6.5	Low----------	0.37	5	3	1-2
Fence	8-48	8-18	1.50-1.60	0.2-0.6	0.17-0.22	3.6-6.5	Low----------	0.37			
	48-60	5-15	1.50-1.60	0.2-0.6	0.17-0.22	4.5-7.8	Low----------	0.37			
15*:											
Carbondale------	0-60	---	0.15-0.40	0.2-6.0	0.35-0.45	5.6-7.8	----------	----	2	2	40-65
Cathro----------	0-8	---	0.28-0.45	0.2-6.0	0.45-0.55	5.6-7.8	----------	----	2	2	60-85
	8-43	---	0.15-0.30	0.2-6.0	0.35-0.45	5.6-7.8	----------	----			
	43-60	10-30	1.50-1.70	0.2-2.0	0.11-0.22	6.6-8.4	Low----------	----			
17*:											
Greenwood-------	0-6	---	0.30-0.40	>6.0	0.55-0.65	3.6-4.4	----------	----	2	5	55-75
	6-60	---	0.10-0.25	0.6-6.0	0.45-0.55	3.6-4.4	----------	----			
Dawson----------	0-13	---	0.30-0.40	>6.0	0.55-0.65	3.6-4.4	----------	----	2	7	65-85
	13-30	---	0.19-0.29	0.2-6.0	0.35-0.45	3.6-4.4	----------	----			
	30-60	0-10	1.56-1.74	6.0-20	0.03-0.10	4.5-6.5	Low----------	----			
20B, 20D, 20F----	0-31	0-12	1.35-1.60	2.0-6.0	0.08-0.12	4.5-6.5	Low----------	0.17	4	2	.5-2
Karlin	31-60	0-10	1.40-1.70	6.0-20	0.02-0.04	5.1-6.5	Low----------	0.17			
23B, 23D---------	0-6	0-15	1.35-1.65	2.0-6.0	0.09-0.12	5.1-6.5	Low----------	0.17	5	2	.5-3
Escanaba	6-21	0-15	1.30-1.65	2.0-6.0	0.08-0.11	5.1-7.3	Low----------	0.17			
	21-34	5-15	1.30-1.65	2.0-6.0	0.09-0.11	5.1-7.3	Low----------	0.17			
	34-46	7-20	1.30-1.70	0.6-2.0	0.12-0.17	6.6-7.8	Low----------	0.28			
	46-60	4-20	1.30-1.70	0.6-2.0	0.10-0.16	6.6-7.8	Low----------	0.28			
24B, 24D, 24F----	0-4	5-15	1.30-1.65	2.0-6.0	0.12-0.15	5.6-6.5	Low----------	0.20	5	3	1-3
Emmet	4-16	10-18	1.40-1.70	2.0-6.0	0.11-0.14	6.1-7.3	Low----------	0.20			
	16-33	15-25	1.60-2.00	0.6-2.0	0.11-0.18	6.6-7.8	Moderate-----	0.32			
	33-60	8-18	1.40-1.65	2.0-6.0	0.08-0.12	7.4-8.4	Low----------	0.32			
25B, 25D, 25F----	0-4	3-11	1.20-1.65	2.0-6.0	0.10-0.18	4.5-6.5	Low----------	0.24	3	3	1-3
Pence	4-16	2-12	1.35-1.45	2.0-6.0	0.10-0.15	4.5-6.0	Low----------	0.24			
	16-27	2-10	1.65-1.75	2.0-6.0	0.05-0.08	4.5-6.0	Low----------	0.10			
	27-60	0-4	1.35-1.80	>6.0	0.02-0.05	5.1-6.5	Low----------	0.10			
26----------	0-6	0-10	1.35-1.40	6.0-20	0.07-0.09	5.6-7.8	Low----------	0.17	5	2	4-12
Deford	6-60	0-12	1.40-1.60	6.0-20	0.05-0.07	5.6-8.4	Low----------	0.17			
32A----------	0-6	0-10	1.30-1.55	6.0-20	0.07-0.09	4.5-6.0	Low----------	0.15	5	1	1-2
Rousseau	6-31	0-10	1.30-1.60	6.0-20	0.06-0.11	4.5-6.5	Low----------	0.15			
	31-60	0-10	1.50-1.65	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.15			

See footnote at end of table.

TABLE 18.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
35B, 35D, 35F----	0-25	2-15	1.15-1.60	0.6-2.0	0.12-0.20	5.6-7.3	Low----------	0.24	4	3	1-3
Nadeau	25-30	8-18	1.25-1.60	0.6-2.0	0.04-0.09	5.6-7.8	Low----------	0.17			
	30-60	0-5	1.45-1.65	>20	0.01-0.04	7.9-8.4	Low----------	0.10			
36B, 36D, 36F----	0-6	0-10	1.30-1.55	6.0-20	0.07-0.09	5.1-6.0	Low----------	0.15	5	1	1-2
Rousseau	6-31	0-10	1.30-1.60	6.0-20	0.06-0.08	4.5-6.5	Low----------	0.15			
	31-60	0-10	1.50-1.65	6.0-20	0.05-0.07	5.6-6.5	Low----------	0.15			
46B, 46D---------	0-3	6-13	1.35-1.70	0.6-2.0	0.11-0.18	5.6-6.5	Low----------	0.24	4	3	1-2
Oconto	3-27	8-18	1.40-1.65	0.6-2.0	0.10-0.19	6.1-7.8	Low----------	0.24			
	27-60	0-3	1.50-1.80	>6.0	0.02-0.07	7.4-8.4	Low----------	0.15			
47A----------	0-4	0-10	1.35-1.50	6.0-20	0.07-0.09	4.5-6.5	Low----------	0.15	5	1	2-4
Wainola	4-37	2-12	1.35-1.45	6.0-20	0.06-0.11	4.5-6.5	Low----------	0.15			
	37-60	0-10	1.25-1.50	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.15			
49B, 49D, 49F----	0-3	0-10	1.15-1.60	2.0-6.0	0.10-0.12	5.1-7.3	Low----------	0.17	4	2	.5-3
Mancelona	3-26	0-15	1.25-1.50	6.0-20	0.06-0.12	5.6-7.8	Low----------	0.17			
	26-31	10-25	1.25-1.60	2.0-6.0	0.06-0.16	6.1-7.8	Low----------	0.17			
	31-60	0-10	1.20-1.50	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
50*.											
Pits											
55----------	0-9	0-10	1.00-1.20	6.0-20	0.04-0.06	3.6-6.0	Low----------	0.15	5	1	4-15
Kinross	9-60	0-10	1.50-1.70	6.0-20	0.04-0.06	4.5-6.5	Low----------	0.15			
57B, 57D, 57F----	0-3	2-6	1.35-1.65	6.0-20	0.09-0.12	4.5-6.5	Low----------	0.17	5	2	<1
Vilas	3-17	2-6	1.50-1.65	6.0-20	0.07-0.12	4.5-6.5	Low----------	0.17			
	17-34	1-3	1.50-1.70	6.0-20	0.05-0.08	4.5-6.5	Low----------	0.17			
	34-60	0-3	1.50-1.70	6.0-20	0.04-0.07	5.1-6.5	Low----------	0.17			
59A----------	0-5	2-12	1.10-1.65	0.6-2.0	0.12-0.18	4.5-6.0	Low----------	0.24	4	3	1-3
Channing	5-23	2-15	1.25-1.70	0.6-2.0	0.11-0.16	4.5-6.0	Low----------	0.24			
	23-60	0-5	1.50-1.65	>20	0.02-0.04	5.1-6.5	Low----------	0.10			
60B, 60D, 60F----	0-3	0-5	1.45-1.65	6.0-20	0.07-0.09	5.1-6.5	Low----------	0.15	5	1	1-2
Zimmerman	3-60	0-10	1.50-1.70	6.0-20	0.06-0.10	6.1-7.3	Low----------	0.17			
64B, 64D, 64F----	0-5	0-5	1.35-1.45	6.0-20	0.05-0.09	4.5-6.0	Low----------	0.15	5	1	.5-1
Rubicon	5-41	0-10	1.30-1.60	6.0-20	0.04-0.08	4.5-6.0	Low----------	0.15			
	41-60	0-5	1.40-1.55	6.0-20	0.04-0.06	5.6-6.5	Low----------	0.15			
65*.											
Pits and Dumps											
66D*:											
Zimmerman-------	0-3	2-5	1.45-1.65	6.0-20	0.07-0.09	5.1-6.5	Low----------	0.17	5	2	1-2
	3-60	0-10	1.50-1.70	6.0-20	0.06-0.10	6.1-7.3	Low----------	0.17			
Rock outcrop.											
66F*:											
Zimmerman-------	0-3	0-5	1.45-1.65	6.0-20	0.07-0.09	5.1-6.5	Low----------	0.15	5	1	1-2
	3-60	0-10	1.50-1.70	6.0-20	0.06-0.10	6.1-7.3	Low----------	0.17			
Rock outcrop.											
67.											
Udorthents											

See footnote at end of table.

TABLE 18.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
68D*, 68F*:											
Pemene	0-27	3-15	1.15-1.60	2.0-6.0	0.11-0.17	4.5-6.5	Low	0.24	5	3	.5-3
	27-60	8-20	1.30-1.60	0.6-6.0	0.10-0.16	5.6-7.8	Low	0.24			
Rock outcrop.											
69D*, 69F*:											
Emmet	0-4	5-15	1.30-1.65	2.0-6.0	0.12-0.15	5.6-6.5	Low	0.20	5	3	1-3
	4-16	10-18	1.40-1.70	2.0-6.0	0.11-0.14	6.1-7.3	Low	0.20			
	16-33	15-25	1.60-2.00	0.6-2.0	0.11-0.18	6.6-7.8	Moderate	0.32			
	33-60	8-18	1.40-1.65	2.0-6.0	0.08-0.12	7.4-8.4	Low	0.32			
Rock outcrop.											
70B	0-10	5-20	1.35-1.70	0.6-2.0	0.10-0.18	6.1-7.8	Low	0.24	5	3	1-3
Solona	10-23	12-18	1.45-1.65	0.6-2.0	0.09-0.19	6.6-7.8	Low	0.32			
	23-60	5-20	1.45-1.70	0.6-2.0	0.08-0.19	7.4-8.4	Low	0.32			
71	0-9	10-18	1.30-1.60	2.0-6.0	0.10-0.15	6.1-7.8	Low	0.20	5	3	4-7
Ensley	9-20	10-25	1.30-1.70	0.6-2.0	0.10-0.18	6.6-8.4	Moderate	0.20			
	20-60	8-18	1.45-1.70	2.0-6.0	0.08-0.12	6.6-8.4	Low	0.20			
72*:											
Aquents.											
Histosols.											
75B	0-4	7-18	1.35-1.60	0.6-2.0	0.20-0.24	5.1-7.3	Low	0.37	5	5	2-4
Alstad	4-21	6-16	1.55-1.65	0.6-2.0	0.13-0.22	5.1-7.3	Low	0.32			
	21-42	18-35	1.55-1.70	0.6-2.0	0.13-0.19	5.6-7.8	Low	0.32			
	42-60	8-30	1.60-1.80	0.2-0.6	0.09-0.19	6.1-8.4	Low	0.32			
76B*, 76D*:											
Emmet	0-4	5-15	1.30-1.65	2.0-6.0	0.12-0.15	5.6-6.5	Low	0.20	5	3	1-3
	4-16	10-18	1.40-1.70	2.0-6.0	0.11-0.14	6.1-7.3	Low	0.20			
	16-33	15-25	1.60-2.00	0.6-2.0	0.11-0.18	6.6-7.8	Moderate	0.32			
	33-60	8-18	1.40-1.65	2.0-6.0	0.08-0.12	7.4-8.4	Low	0.32			
Pemene	0-27	3-15	1.15-1.60	2.0-6.0	0.11-0.17	4.5-6.5	Low	0.24	5	3	.5-3
	27-60	8-20	1.30-1.60	0.6-6.0	0.10-0.16	5.6-7.8	Low	0.24			
77D*, 77F*:											
Rock outcrop.											
Pemene	0-27	3-15	1.15-1.60	2.0-6.0	0.11-0.17	4.5-6.5	Low	0.24	5	3	.5-3
	27-60	8-20	1.30-1.60	0.6-6.0	0.10-0.16	5.6-7.8	Low	0.24			
79	0-6	18-27	1.35-1.55	0.6-2.0	0.17-0.25	6.1-7.3	Low	0.32	3	6	2-5
Hettinger	6-14	27-35	1.35-1.55	0.2-0.6	0.18-0.20	6.6-7.8	Low	0.43			
	14-26	27-35	1.40-1.70	0.06-0.2	0.11-0.20	7.4-7.8	Low	0.43			
	26-60	27-50	1.50-1.75	0.06-0.2	0.10-0.20	7.9-8.4	Low	0.43			
80B, 80D	0-5	5-15	1.10-1.60	2.0-6.0	0.10-0.16	5.6-7.3	Low	0.24	3	3	1-3
Longrie	5-21	10-18	1.20-1.65	0.6-2.0	0.09-0.19	5.6-7.3	Low	0.32			
	21	---	---	---	---	---	---	---			
82B, 82D	0-23	5-15	1.40-1.70	0.6-2.0	0.15-0.20	5.1-6.5	Low	0.32	5	3	1-3
Ubly Variant	23-60	30-40	1.80-2.00	0.06-0.2	0.12-0.18	6.1-7.3	Moderate	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 19.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "frequent," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
10*:												
Waucedah	D	Frequent	Brief to very long.	Mar-May	+2-0	Apparent	Jan-Dec	>60	---	High	Moderate	Low.
Cathro	A/D	None	---	---	+1-1.0	Apparent	Sep-Jun	>60	---	High	High	Low.
13B, 13D, 13F----- Pemene	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
14B, 14D---------- Fence	B	None	---	---	>6.0	---	---	>60	---	High	Low	High.
15*:												
Carbondale	A/D	None	---	---	+1-1.0	Apparent	Sep-May	>60	---	High	High	Moderate.
Cathro	A/D	None	---	---	+1-1.0	Apparent	Sep-Jun	>60	---	High	High	Low.
17*:												
Greenwood	A/D	None	---	---	+1-1.0	Apparent	Sep-Jun	>60	---	High	High	High.
Dawson	A/D	None	---	---	+1-1.0	Apparent	Sep-Jun	>60	---	High	High	High.
20B, 20D, 20F----- Karlin	A	None	---	---	>6.0	---	---	>60	---	Low	Low	High.
23B, 23D---------- Escanaba	A	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
24B, 24D, 24F----- Emmet	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.
25B, 25D, 25F----- Pence	B	None	---	---	>6.0	---	---	>60	---	Low	Low	Moderate.

See footnote at end of table.

TABLE 19.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
26---------- Deford	A/D	None--------	---	---	+1-1.0	Apparent	Oct-Jun	>60	---	Moderate	Low------	Moderate.
32A---------- Rousseau	A	None--------	---	---	2.5-6.0	Apparent	Nov-May	>60	---	Low------	Low------	Moderate.
35B, 35D, 35F----- Nadeau	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
36B, 36D, 36F----- Rousseau	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
46B, 46D---------- Oconto	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
47A---------- Wainola	B	None--------	---	---	0.5-1.5	Apparent	Oct-May	>60	---	Moderate	Low------	Moderate.
49B, 49D, 49F----- Mancelona	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
50*. Pits												
55---------- Kinross	A/D	None--------	---	---	+1-1.0	Apparent	Sep-Jun	>60	---	Moderate	High-----	Moderate.
57B, 57D, 57F----- Vilas	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	High.
59A---------- Channing	B	None--------	---	---	0.5-1.5	Apparent	Nov-May	>60	---	High-----	Moderate	Moderate.
60B, 60D, 60F----- Zimmerman	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	High.
64B, 64D, 64F----- Rubicon	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	High.

See footnote at end of table.

TABLE 19.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
65*. Pits and Dumps												
66D*, 66F*: Zimmerman	A	None	---	---	>6.0	---	---	>60	---	Low	Low	High.
Rock outcrop.												
67. Udorthents												
68D*, 68F*: Pemene	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
Rock outcrop.												
69D*, 69F*: Emmet	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.
Rock outcrop.												
70B--- Solona	C	None	---	---	0.5-1.5	Apparent	Nov-May	>60	---	High	High	Low.
71--- Ensley	B/D	None	---	---	+1-1.0	Apparent	Oct-Jun	>60	---	High	High	Low.
72*: Aquents.												
Histosols.												
75B--- Alstad	C	None	---	---	0.5-1.5	Apparent	Nov-May	>60	---	High	Moderate	Moderate.
76B*, 76D*: Emmet	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.
Pemene	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.

See footnote at end of table.

TABLE 19.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
77D*, 77F*: Rock outcrop.												
Pemene	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
79 Hettinger	C/D	None	---	---	+1-1.0	Perched	Oct-Jun	>60	---	High	High	Low.
80B, 80D Longrie	B	None	---	---	>6.0	---	---	20-40	Hard	Moderate	Low	Low.
82B, 82D Ubly Variant	C	None	---	---	>6.0	---	---	>60	---	High	Low	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 20.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Alstad	Fine-loamy, mixed Aquic Eutroboralfs
Aquents	Mixed, nonacid, frigid Aquents
Carbondale	Euic Hemic Borosaprists
Cathro	Loamy, mixed, euic Terric Borosaprists
Channing	Coarse-loamy over sandy or sandy-skeletal, mixed, frigid Entic Haplaquods
Dawson	Sandy or sandy-skeletal, mixed, dysic Terric Borosaprists
Deford	Mixed, frigid Typic Psammaquents
Emmet	Coarse-loamy, mixed Typic Eutroboralfs
Ensley	Coarse-loamy, mixed, nonacid, frigid Aeric Haplaquepts
Escanaba	Loamy, mixed Arenic Eutroboralfs
Fence	Coarse-silty, mixed, frigid Alfic Haplorthods
Greenwood	Dysic Typic Borohemists
Hettinger	Fine-loamy, mixed, nonacid, frigid Mollic Haplaquepts
Histosols	Euic, frigid Histosols
Karlin	Sandy, mixed, frigid Entic Haplorthods
Kinross	Sandy, mixed, frigid Typic Haplaquods
Longrie	Coarse-loamy, mixed, frigid Entic Haplorthods
Mancelona	Sandy, mixed, frigid Alfic Haplorthods
Nadeau	Loamy-skeletal, mixed Psammentic Eutroboralfs
Oconto	Coarse-loamy, mixed Typic Eutroboralfs
*Pemene	Coarse-loamy, mixed Glossic Eutroboralfs
Pence	Sandy, mixed, frigid Entic Haplorthods
Rousseau	Sandy, mixed, frigid Entic Haplorthods
Rubicon	Sandy, mixed, frigid Entic Haplorthods
Solona	Coarse-loamy, mixed Aquic Eutroboralfs
Ubly Variant	Fine-silty, mixed, frigid Dystric Eutrochrepts
Udorthents	Loamy, mixed, nonacid frigid Udorthents
Vilas	Sandy, mixed, frigid Entic Haplorthods
Wainola	Sandy, mixed, frigid Entic Haplaquods
Waucedah	Coarse-loamy, mixed, nonacid, frigid Histic Humaquepts
Zimmerman	Mixed, frigid Alfic Udipsamments

Interpretive Groups

INTERPRETIVE GROUPS

(Dashes indicate that the soil was not assigned to the interpretive group)

Soil name and map symbol	Land capability	Prime farmland	Habitat type		Woodland ordination symbol	Michigan soil management group
			Primary	Secondary		
10---------- Waucedah---------- Cathro----------	VIw	---	FMC-C	FMC	 3W 5W	 L-4c M/3c
13B---------- Pemene	IIIs	Yes	TM	ATD	4S	3a
13D---------- Pemene	IVe	---	TM	ATD	4S	3a
13F---------- Pemene	VIIe	---	TM	ATD	4R	3a
14B---------- Fence	IIe	Yes	AVO	AOC	3A	2.5a
14D---------- Fence	IVe	---	AVO	AOC	3A	2.5a
15---------- Carbondale---------- Cathro----------	VIw	---	TTM	TTS	 5W 5W	 Mc M/3c
17---------- Greenwood---------- Dawson----------	VIIw	---	PCS	---	 2W 2W	 Mc-a Mc-a
20B---------- Karlin	IIIs	---	TM	TMV	3S	4a
20D---------- Karlin	IVe	---	TM	TMV	3S	4a
20F---------- Karlin	VIIe	---	TM	TMV	3R	4a
23B---------- Escanaba	IIIs	---	TM	AVO	3S	4/2a
23D---------- Escanaba	IVe	---	TM	AVO	3S	4/2a
24B---------- Emmet	IIe	Yes	AVO	AVO-A	3A	3a
24D---------- Emmet	IVe	---	AVO	AVO-A	3A	3a
24F---------- Emmet	VIIe	---	AVO	AVO-A	3R	3a
25B---------- Pence	IIIe	---	TMV	TM	7S	4a-a
25D---------- Pence	IVe	---	TMV	TM	7R	4a-a
25F---------- Pence	VIIe	---	TMV	TM	7R	4a-a
26---------- Deford	Vw	---	TTS	TTM	4W	4c

INTERPRETIVE GROUPS--Continued

Soil name and map symbol	Land capability	Prime farmland	Habitat type		Woodland ordination symbol	Michigan soil management group
			Primary	Secondary		
32A---------- Rousseau	IIIs	---	TMC	TMV	5S	4a
35B---------- Nadeau	IIIs	---	TM	ATD	2S	3/5a
35D---------- Nadeau	IVe	---	TM	ATD	2S	3/5a
35F---------- Nadeau	VIIe	---	TM	ATD	2R	3/5a
36B---------- Rousseau	IIIs	---	AQVac	TMV	5S	4a
36D---------- Rousseau	IVe	---	AQVac	TMV	5S	4a
36F---------- Rousseau	VIIe	---	AQVac	TMV	5R	4a
46B---------- Oconto	IIe	Yes	TM	AVO	3A	3/5a
46D---------- Oconto	IVe	---	TM	AVO	3A	3/5a
47A---------- Wainola	IIIw	---	TMC	TMC-V	6W	4b
49B---------- Mancelona	IIIs	---	AQVac	TM	3S	4a
49D---------- Mancelona	IVe	---	AQVac	TM	3S	4a
49F---------- Mancelona	VIIe	---	AQVac	TM	3R	4a
50. Pits						
55---------- Kinross	VIw	---	PCS	---	2W	5c-a
57B---------- Vilas	IVs	---	AQVac	TMV	6S	5.3a
57D---------- Vilas	VIIs	---	AQVac	TMV	6S	5.3a
57F---------- Vilas	VIIs	---	AQVac	TMV	6R	5.3a
59A---------- Channing	IIIw	---	TMC	---	2W	3/5b
60B---------- Zimmerman	IIIs	---	TMV	AQVac	8S	4a
60D---------- Zimmerman	IVe	---	TMV	AQVac	8S	4a

INTERPRETIVE GROUPS--Continued

Soil name and map symbol	Land capability	Prime farmland	Habitat type		Woodland ordination symbol	Michigan soil management group
			Primary	Secondary		
60F---------- Zimmerman	VIIe	---	TMV	AQVac	8R	4a
64B---------- Rubicon	VIs	---	AQVac	TMV	4S	5.3a
64D---------- Rubicon	VIIs	---	AQVac	TMV	4S	5.3a
64F---------- Rubicon	VIIs	---	AQVac	TMV	4R	5.3a
65. Pits and Dumps						
66D---------- Zimmerman---------- Rock outcrop.	VIIe	---	TMV	AQVac	8S	4a
66F---------- Zimmerman---------- Rock outcrop.	VIIe	---	TMV	AQVac	8R	4a
67. Udorthents						
68D---------- Pemene---------- Rock outcrop.	VIe	---	TM	ATD	4S	3a
68F---------- Pemene---------- Rock outcrop.	VIIe	---	TM	ATD	4R	3a
69D---------- Emmet---------- Rock outcrop.	VIe	---	AVO	ATD	3A	3a
69F---------- Emmet---------- Rock outcrop.	VIIe	---	AVO	ATD	3R	3a
70B---------- Solona	IIw	Yes*	TMC	AVO	3W	3b
71---------- Ensley	Vw	Yes*	TTM	TTS	3W	3c
72. Aquents and Histosols						
75B---------- Alstad	IIw	Yes*	TMC	---	3W	2.5b
76B---------- Emmet---------- Pemene----------	IIe	Yes	TM	ATD	3A 4S	3a 3a
76D---------- Emmet---------- Pemene----------	IVe	---	TM	ATD	3A 4S	3a 3a

See footnote at end of table.

INTERPRETIVE GROUPS--Continued

Soil name and map symbol	Land capability	Prime farmland	Habitat type		Woodland ordination symbol	Michigan soil management group
			Primary	Secondary		
77D---------- Rock outcrop. Pemene----------	VIIe	---	TMV	AQVac	4S	3a
77F---------- Rock outcrop. Pemene----------	VIIe	---	TMV	AQVac	4R	3a
79---------- Hettinger	Vw	Yes*	TTM	TTS	6W	1.5c
80B---------- Longrie	IIIe	---	AVO	ATD	3A	3/Ra
80D---------- Longrie	IVe	---	AVO	ATD	3A	3/Ra
82B---------- Ubly Variant	IIe	Yes	AVO	ATD	3D	2.5a
82D---------- Ubly Variant	IVe	---	AVO	ATD	3D	2.5a

* Where drained.

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